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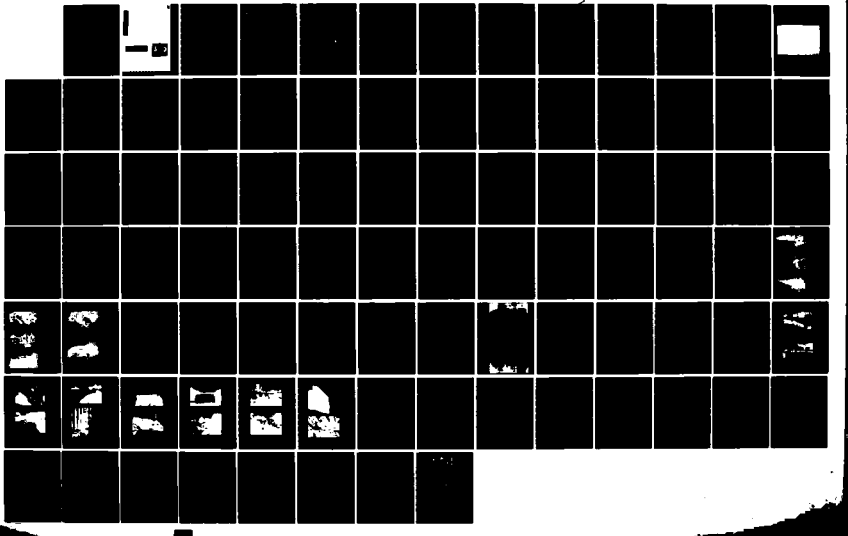

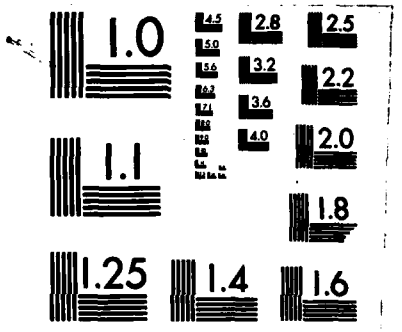

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF
NEDED

JUN 0 3 1980

Honorable J. Joseph Garrahy
Governor of the State of Rhode Island
and Providence Plantations
State House
Providence, Rhode Island 02903

Dear Governor Garrahy:

Inclosed is a copy of the Barden Reservoir Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Management, the cooperating agency for the State of Rhode Island. In addition, a copy of the report has also been furnished the owner, Providence Water Supply Board.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Management for your cooperation in carrying out this program.

Sincerely,

"Original contains color ... All DTIC reproductions will be in black and white"

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

BARDEN RESERVOIR DAM
RI 03003

PAWTUXET RIVER BASIN

SCITUATE, RHODE ISLAND

PHASE 1 INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE 1 - INSPECTION REPORT

Identification No.:	RI 03003
Name of Dam:	Barden Reservoir Dam
Town:	Scituate
County and State:	Providence County, Rhode Island
Stream:	Ponaganset River
Date of Inspection:	October 30, 1979

Brief Assessment

The dam at Barden Reservoir is an earth embankment with a concrete corewall. The dam is approximately 612 feet long, 35 feet high, with an average crest width of about 16 feet. The overflow spillway is located at the right abutment and is an uncontrolled, broad-crested weir, 81.5 feet long, constructed of cut-stone masonry. The dam has two outlet work structures; one, located at the left abutment of the spillway, is a gated 30-inch diameter conduit, and the other is the intake to the former mill complex and is a double-barreled stone masonry box culvert, gated at the upstream face of the dam. Both outlets have controls, operated from the crest of the dam, that are protected by wooden frame gatehouse buildings. Limited construction drawings are available at the offices of the Owner, the Providence Water Supply Board.

The assessment of the facility is based on the visual inspection, since engineering, operational, and maintenance data are not available. The dam is judged to be in GOOD condition, but with several deficiencies that need attention. They include the potential for overtopping due to limited discharge capacity of the overflow spillway; seepage at the toe of the dam near the left abutment; rotting tree roots on the downstream slope; and large trees on the embankment near the left abutment area.

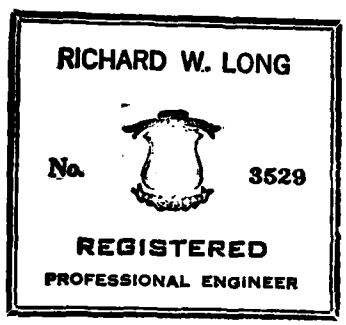
The dam is classified as SMALL in size and a SIGNIFICANT hazard structure in accordance with the recommended guidelines established by the Corps of Engineers. The test flood outflow for this dam is equal to one-half the Probable Maximum Flood (PMF) or approximately 13,240 cfs and would overtop the dam by about 4.4 feet; therefore, the existing spillway capacity is considered to be inadequate to pass routed test flood outflow. The maximum spillway discharge of 4,650 cfs represents only 35 percent of the test flood outflow. Overtopping could result in the failure of this earth embankment.

It is recommended that the Owner engage the services of a registered engineer experienced in the design of dams to accomplish the following: perform more detailed hydrologic studies to evaluate the impact of the test flood on the existing facilities and to improve the capacity of the dam to pass the flood flows reducing the overtopping potential; monitor and develop remedial action for the seepage emerging at the left abutment area; implement a regular maintenance program and establish an "emergency action plan".

Additional recommendations and remedial measures are detailed in Section 7 and should be implemented by the Owner within two years after receipt of this Phase 1 Inspection Report.

CE MAGUIRE, INC.

BY Richard W. Long
Richard W. Long, P.E.
Vice President



This Phase I Inspection Report on Bardens Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase 1 Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase 1 Investigation is to identify expeditiously those dams which may pose hazards to human life or to property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase 1 investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that an unsafe condition be detected.

Phase 1 inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

The Phase I investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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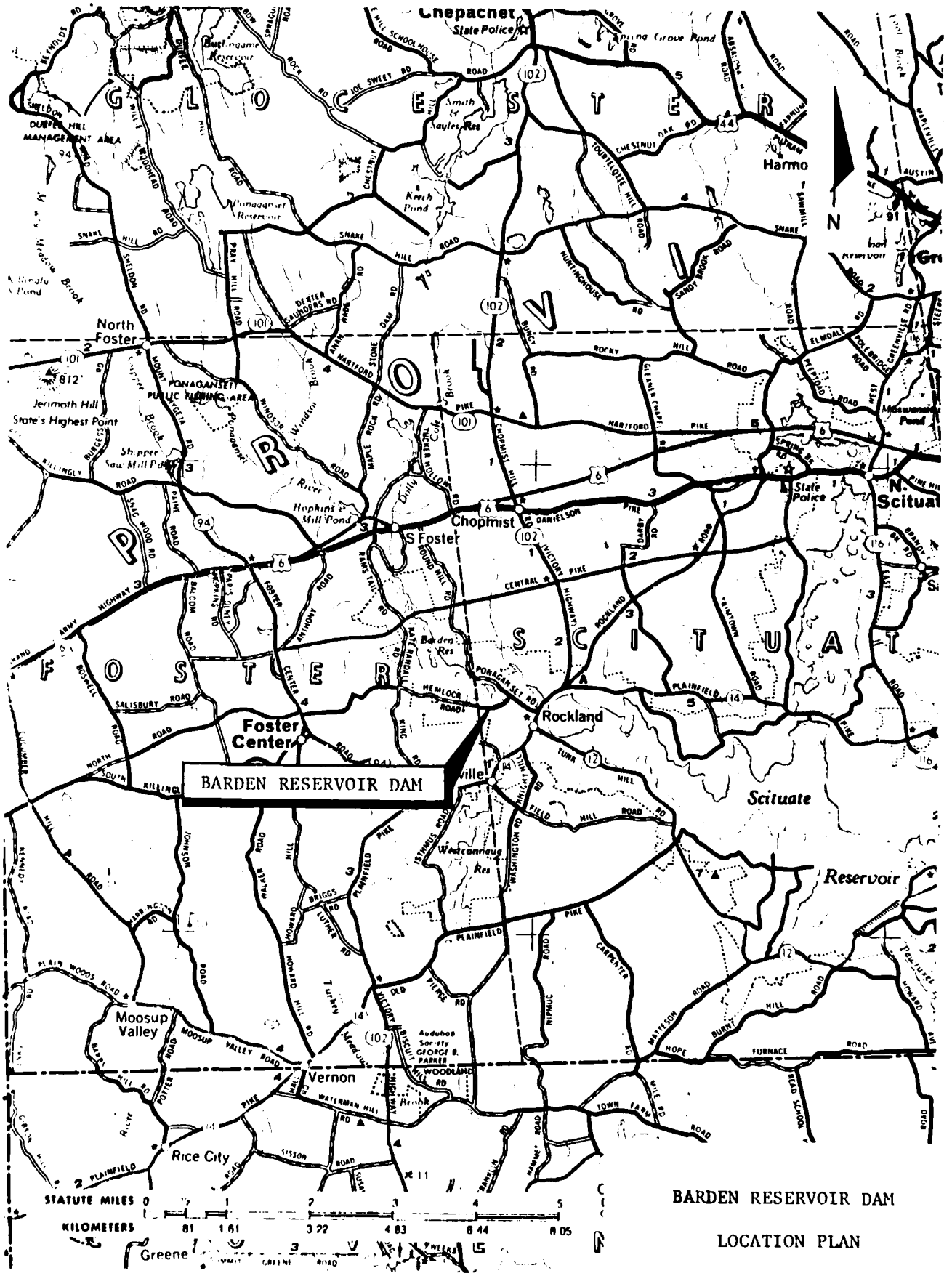
OVERVIEW PHOTO - BARDEN RESERVOIR DAM



BARDEN RESERVOIR DAM

LOCATION PLAN

PLATE NO. 1

NATIONAL DAM INSPECTION PROGRAM

PHASE I - INSPECTION REPORT

NAME OF DAM: BARDEN RESERVOIR DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army through the Corps of Engineers to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. CE Maguire, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Rhode Island. Authorization and notice to proceed was issued to CE Maguire, Inc., under a letter from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-80-C-0013 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

2. Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

3. To update, verify and complete the National Inventory of Dams.

1.2 Description of the Project

a. Location. Barden Reservoir Dam is located in the Town of Scituate, Providence County, Rhode Island. Coordinates of the dam are approximately 41° 47.5'N Latitude and 71° 40.5'W Longitude. (See Plate No. 1). The dam impounds water from the Ponaganset River which drains a 33.0 square mile watershed of rolling terrain. The axis of the dam is oriented in a northwest-southeast alignment with the reservoir located south and west of the dam.

b. Description of Dam and Appurtenances. The dam at Barden Reservoir is approximately 612 feet in length (including the overflow spillway), and is an earth embankment structure with a concrete corewall. The spillway is a stone masonry arched overflow weir about 81.5 feet long located at the right abutment of the dam. There are two outlet work structures for this dam; one located at the left abutment of the spillway is a gated 30-inch diameter conduit, and the other is the intake to the former mill complex and is a double barreled stone masonry box culvert, gated at the upstream slope of the dam. Discharges from the spillway and outlet works flow into the Ponaganset River which leads to the Scituate Reservoir, the main surface water supply of the Providence Water Supply Board.

c. Size Classification. Barden Reservoir has an impoundment capacity at the top of the dam (Elev. 352.2 feet NGVD) equal to 4320 Ac-Ft and a maximum height of dam 35.0 feet. In accordance with the guidelines criteria of the Corps of Engineers, this dam is classified as INTERMEDIATE in size.

d. Hazard Classification. The dam is classified as having a SIGNIFICANT hazard potential because its failure may result in loss of life or property damage. Storage in this reservoir serves as a supplement to the water supply storage in the main Scituate Reservoir pool and constitutes approximately 2.0 percent of the total storage. Estimated downstream water depths due to a possible dam failure discharge of 22,800 CFS at Barden Reservoir may range from 15.0 feet immediately downstream of the Barden Dam to 5.0 feet at a distance 2,000 feet from the dam where it joins the Scituate Reservoir. The rise in water surface elevation in the Scituate Reservoir due to failure of the Barden Reservoir Dam is estimated to be 1.35 feet. The dam failure discharge may damage the Ponaganset Road Bridge and temporarily disrupt the overhead utilities that are adjacent to the road. The failure wave may also damage Route 102. The failure of this dam may result in a shortage of water to the City of Providence.

e. Ownership. Barden Reservoir is owned by the City of Providence and is operated and managed by the Providence Water Supply Board.

f. Operator. Operating personnel are under the direction of:

Chief Engineer
Providence Water Supply Board
552 Academy Avenue
Providence, RI 02908

g. Purpose of Dam. The dam at Barden Reservoir impounds water from the Ponaganset River for the water supply system of the City of Providence.

h. Design and Construction History. Record drawings indicate the dam was constructed about 1883 to provide a water supply for an adjacent mill complex. The dam was raised apparently an additional five feet in June, 1884, by the construction of a heavy ashlar masonry wall along the upstream crest of the dam. In 1915, the Providence City Council and the State of Rhode Island approved an Act which established the Providence Water Supply Board and permitted the City to develop an increased water supply. Barden Reservoir and its watershed were acquired shortly thereafter.

In August, 1963, the reservoir was drained and repairs made to the spillway including repointing the downstream granite block face, and the installation of a new concrete approach slab. A new trash rack was installed at the outlet structure, the draw-off gate and its control mechanism were reconditioned, and the gatehouse rebuilt. At the former mill intake structure, new wooden gates and operating stands were installed, the masonry shaft repointed, and the timber trestle service bridge which provides access to the intake structure was replaced. To provide a more suitable access to the dam, a new graveled road was constructed from Ponaganset Road to the dam. This work was completed on September 20, 1963, at which time refilling of the reservoir began.

Additional work on the outlet works adjacent to the spillway was accomplished during the summer of 1978 when the control mechanism, stem, and guides were replaced and a vandal-proof housing erected to cover the control mechanism.

No subsequent work has been accomplished at the dam.

i. Normal Operational Procedure. Barden Reservoir is operated as a supply impoundment of the Scituate Reservoir system which supplies water to the City of Providence. Normally, the outlet works remain closed throughout the year and all water that flows to the main supply at Gainer Dam downstream is discharge from the overflow spillway. Outlet works' gates are operated generally during drought periods to supplement the main supply, during periods of excess rainfall to relieve the load imposed against Barden Dam and to lower the pool surface level for maintenance and repair. Water surface levels are recorded weekly and the dam is visited daily for spot inspection by operating or watershed personnel.

1.3 Pertinent Data

a. Drainage Area. The Barden Reservoir Dam drainage basin, located in Providence County in Scituate, Rhode Island, is oval in shape with a length of 46,000 feet, a width of 30,000 feet, and a total drainage area of 33.0 sq. miles (See Appendix D for Basin Map). Twenty percent of the watershed (or 6.6 sq. miles) is swampy or occupied by water storage reservoirs. The topography is considered moderately hilly to steep with elevations ranging from a high of 700.0 feet NGVD to 345.10 feet at the spillway crest. Basin slopes average 0.02 ft./ft. to 0.05 ft./ft. and are generally moderate to steep. The time of concentration for the entire watershed is more than three hours and is relatively small, increasing the probability that all surface runoff will peak simultaneously at the reservoir site during a high intensity rainfall event. The natural storage areas in the watershed tend moderately to dampen and delay the peak of the surface runoff.

b. Discharge at Damsite. There is limited discharge data available for this dam. The estimated extreme freshet calculated at this damsite is 2,607 C.F.S. according to records of the Department of Environmental Management - State of Rhode Island.

1. Outlet Works:

Conduit size = 30" Diameter Pipe
Invert elevation = 318.70 NGVD
Discharge capacity = 124.0 C.F.S.
at spillway crest elevation 345.10
Discharge Capacity = 141 C.F.S. at the top of the dam Elev. 352.2
Discharge Capacity = 151 C.F.S. at Test Flood level Elev. 356.65

2. Maximum known flood at damsite = Unknown

3. Ungated spillway capacity at top of dam = 4,654 C.F.S.

4. Total project discharge at top of dam = 4,795 C.F.S.
(Spillway plus outlet discharge)

5. Total project discharge at Test Flood Level = 13,252 C.F.S.
(Spillway plus dam overflow)

* Outlet Works conduit to former mill assumed permanently closed and not considered in above calculations.

c. Elevations. (Feet above NGVD)

1.	Streambed at toe of dam	317.0
2.	Bottom of cut off	Unknown
3.	Maximum tail water	Unknown
4.	Recreation pool	N/A
5.	Full flood control pool	N/A
6.	Spillway crest (ungated)	345.10
7.	Design discharge (original design)	Unknown
8.	Top of dam	352.20
9.	Test flood design surcharge (with overtopping of dam)	356.65

d. Reservoir. (Length in feet)

1.	Normal pool	10,000
2.	Flood control pool	N/A
3.	Spillway crest pool	10,000
4.	Top of dam	10,000
5.	Test flood pool	10,000

e. Storage. (Acre-Feet)

1.	Normal pool	2,620
2.	Flood control pool	N/A
3.	Spillway crest	2,620
4.	Top of Dam	4,320
5.	Test Flood pool	5,410

6. Net storage between top of dam (Elev. 352.20) and spillway crest is 1,704 Ac.-Ft. and represents 0.97 inches of runoff from the drainage area of 33.0 square miles.

7. Each foot of surcharge storage from spillway crest to the top of dam equals 0.136 inches of runoff.

f. Reservoir Surfaces (acres)

1.	Recreation Pool	N/A
2.	Flood Control Pool	N/A
3.	Spillway Crest	240
4.	Test Flood Pool	430

g. Dam.

1.	Type	Earth embankment with concrete core wall.
2.	Length (including 81.5 feet of spillway)	612 feet
3.	Height	35 feet
4.	Top width	16 feet
5.	Side slopes	1V on 2H
6.	Zoning	Unknown
7.	Impervious core	concrete core wall
8.	Cutoff	Drawings indicate corewall extends to bedrock.
9.	Grout curtain	Unknown
10.	Other	--

h. Diversion and Regulating Tunnel.

1.	Descriptions	N/A

i. Spillway.

1.	Type	Free overflow, broad crested, stone masonry, curved.

2.	Length of weir	81.5 feet
3.	Crest elevation without flash boards	345.1
4.	Gates	Uncontrolled
5.	U/S Channel	Reservoir bed; straight approach
6.	D/S Channel	Natural bed with outcropping of bedrock; curved in alignment.
7.	General	Channel D/S obstructed by trees, old bridge abutments and Ponaganset Road bridge.

j. Regulating Outlets.

Refer to Paragraph 1.2b "Description of Dam and Appurtenances", Page 3, for description of outlet works.

At Intake to Former Mill

1.	Downstream invert	319.7
2.	Size	4'-4" x 3'-7½", 3'-0" x 2'-6"
3.	Description	Double barreled box culvert
4.	Control Mechanism	Manually operated sluice gate
5.	Other	Control housed in wooden frame gatehouse.

At Spillway Left Abutment

1.	Downstream invert	318.70
2.	Size	30 inch diameter
3.	Description	Cast iron pipe
4.	Control Mechanism	Manually operated sluice gate.
5.	Other	Control housed in wooden frame gatehouse

SECTION 2

ENGINEERING DATA

2.1 Design Data

The following documents which contain the principal information regarding this dam were reviewed in the preparation of this report.

1. Scituate Reservoir - Details of Dam at Barden Reservoir - Traced from Plan (without Title or Date) in possession of E. E. Goff, C.E.; scales as noted, June 21, 1918.

2. Scituate Reservoir - Plan for Raising Dam at Barden Reservoir - Traced from Plan in Possession of E. E. Goff, C.E. scales as noted, June 21, 1918.

3. Barden Reservoir - Repairs to Draw Off Structures, Sheet 1 of 2, and Sheet 2 of 2, dated August 15, 1963.

4. Barden Reservoir, Scituate, Rhode Island - Installation of New Sluice Gate, Operator and Security Enclosure, dated April 20, 1978.

5. Scituate Watershed - Storage Reservoir Statistics, dated November 8, 1956.

2.2 Construction Data

No record of construction or repairs exists to supplement the above information.

2.3 Operation Data

No record of operation for this facility has been maintained. Water surface levels are recorded weekly and are used to estimate available storage. This information is also published in the annual reports issued by the Providence Water Supply Board.

2.4 Evaluation of Data

a. Availability. The information noted above for this facility is available from the files of the Chief Engineer, City of Providence, Providence Water Supply Board.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design

and construction data, but is based primarily on visual inspections, past performance, and sound engineering judgment.

c. Validity. The validity of the limited data must be verified.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The Phase 1 Inspection of the dam at Barden Reservoir was performed on October 30, 1979, by representatives of CE Maguire, Inc. and Geotechnical Engineers. The inspection team was accompanied in the field by Mssr.'s E. Bondereski, Engineer; H. Bergy, Watershed Manager; and J. Lees, Master Mechanic of the Water Supply Board operating staff.

Based on the visual inspection, history, and general appearance, the dam at Barden Reservoir and its appurtenances are judged to be in GOOD condition.

b. Dam. The dam is an earth embankment structure approximately 612 feet long (including the masonry spillway), 35 feet high, with an average crest width of 16 feet.

The embankment has the spillway training wall as the right abutment and the natural hillside as the left abutment. Available plans dated 1883 indicate the dam is constructed of puddled gravel, sand and clay, with a concrete core wall extending to rock or to at least 6 feet below original ground. The core wall extends from the right abutment wall to about Sta 2+90, where the top of the original core wall intersected the original ground surface. Plans dated 1884 indicate the dam, core wall, and spillway were raised by 5 feet, with the addition of an upstream masonry wall. The length of the embankment crest was increased from 290 feet to about 352 feet when the dam was raised.

1. Crest - The crest of the dam is about 16 feet wide and covered with grass with no signs of erosion. The 1884 drawing indicates that the crest of the dam and the top of the upstream wall are at the same elevation, 5 feet above spillway level. During the inspection, the crest was observed to be 6.5 feet above spillway elevation or about 1.5 feet above the top of the upstream wall.

   A small, dead pine tree is located on the crest at about Sta 1+20. From about Sta 3+00 to Sta 3+52 (west abutment), there are several large deciduous trees up to about 10 inches in diameter.

   Vehicle tire tracks with slight ruts and matted grass run down the center of the crest, indicating only light traf-

fic. Unauthorized vehicle access is prevented by a locked gate on the access road.

2. Upstream Slope - From Sta 0+00 to Sta 2+49 there is a vertical mortared stone wall above the water level. The wall is in good condition and alignment. The top of the wall is 5 feet above the spillway elevation and about 18 inches below the crest of the dam. A grassed slope extends from the top of the upstream wall to the crest. The upstream slope below the masonry wall was entirely submerged at the time of inspection. Riprap could be observed on the slope to a depth of 2 to 3 feet below the water surface and appeared in good condition. (See photos C-1,2)

   From Sta 2+49 to 3+00 there is no stone wall and the upstream slope is covered with 6-inch to 18-inch riprap overgrown with brush, vines, and numerous trees up to 3 inches in diameter. The riprap extends to within about 1.5 feet from the crest; the area from the top edge of the riprap to the crest is covered with grass.

   The riprap was missing in several areas above the waterline. Riprap on the upstream slope from Sta 2+49 to Sta 3+00 could be observed below water level to a depth of 2 to 3 feet and appeared to be in good condition.

   From Sta 3+00 to Sta 3+52 at the west abutment, the upstream slope is rather irregular in shape blending into the natural terrain and is covered with brush and several trees up to 10 inches in diameter. There appeared to be no riprap from Sta 3+00 to Sta 3+52.

3. Downstream Slope and Toe - The downstream slope is covered with brush, vines, grass and trees up to 2 inches in diameter, with numerous rotted stumps up to 6 inches in diameter. An unmortared stone masonry wall exists along the toe of the dam from the spillway wall to about Sta 1+60. (See photo C-3)

   The masonry wall at the toe was damp near the junction with the spillway wall with signs of previous seepage. The remainder of the wall was dry. There were no signs of movement of the wall.

   An animal hole about 6 inches in diameter was located at about Sta 1+20, at an elevation about 5 feet above the top of the toe wall.

Seepage was noted at the toe where the dam contacts the left abutment, at about Sta 2+34. The elevation of the seepage was 24.5 feet below the crest of the dam (18 feet below the water level in the reservoir). The water was clear, and the quantity of flow was estimated to be about 1 gpm. From the seepage area, water flowed along the toe to the low-level outlet channel. (See photo C-14)

Slight seepage was also noted from the sides and roof of the low-level outlet tunnels and from the wing walls.

Several large pine trees up to 12-inch diameter are growing just at the toe of the downstream slope from Sta 2+30 to about Sta 3+00.

c. Appurtenant Structures.

1. Spillway and Training Walls - A stone masonry uncontrolled overflow spillway is located at the right abutment of the dam. The spillway weir is constructed of large granite slabs placed in a slight upstream arc (81.5 feet) that is founded on a large exposed bedrock formation. The approach channel to the spillway is open with the easterly training wall extending upstream approximately 200 feet providing protection against wave action for Hemlock Road. Downstream below the weir crest, the channel is confined within cut stone masonry training walls and the channel bed is the exposed bedrock monolith. (See photos C-3, 4, 5.)

After flowing over the spillway structure, the water passes down a steep slope of exposed bedrock into the discharge channel. The bedrock is moderately jointed, with the exposed surface representing the plane of the primary joint set. The bedrock slope is irregular, with several large protruding blocks of rock. Slight seepage was observed from several rock joints near the right downstream training wall.

Because of water flowing over the spillway at the time of inspection, it was not possible to inspect the condition of the downstream face of the spillway.

The spillway structure appeared to be in good condition. The easterly training wall, spillway approach slab, and the downstream granite block face, repaired in 1965, remain tight and sound. The masonry training wall at the left abutment of the spillway had evidence of minor seepage through the joints. (See photo C-13)

2 Outlet Works - There are two outlet works for Barden Reservoir, one located at about the midpoint of the earth embankment, and the second at the left abutment of the spillway.

a) The outlet works at the midpoint of the embankment is the former intake to the mill complex that was located downstream from the dam. It consists of an inlet structure with control gates, a double barreled stone masonry box culvert through the dam, and the outlet headwall structure at the downstream toe. (See photos C-6, 7)

The approach channel is recessed into the upstream slope of the dam and is defined by sloping cut stone masonry retaining walls spaced about 10 feet apart. Sluice gates are mounted on the intake headwall and are controlled by manual operation in the gatehouse structure above. The gate openings are 4'-4" x 3'-7½" and 3'-0" x 2'-6". The conduits through the embankment are masonry box culverts approximately 4'-0" square and 75 feet long. The outlet headwall is also recessed into the downstream slope of the dam and all discharges flow through a masonry channel to the Ponaganset River below the dam.

The components of this outlet were in good condition with the controls housed in a secure structure with ready access from the dam crest. Representatives from the operating staff indicated they rarely use this outlet for control of the impoundment water level because they have experienced difficulty in seating the gates in the past.

b) The second outlet works is located at the left abutment of the spillway and includes an upstream headwall and trash rack, a masonry box culvert approach conduit, wet well, and 30-inch controlled discharge conduit. The sluice gate control operating mechanism was reportedly refurbished in 1978 and was operated by the inspection team and appeared to be in excellent condition. The conduit downstream from the gate house is a 30-inch cast iron pipe that protrudes through the downstream face of the spillway. (See photo C-8)

d. Reservoir Area. The reservoir formed by the dam is approximately 240 acres and provides a storage for 853 million gallons. The reservoir extends a distance of about 2 miles upstream from the dam and has an average width of 1,000 feet.

The major portion of the impoundment lies in the Town of Foster, while the dam and a small area of the lake that is formed lies in Scituate. The shoreline is undeveloped and heavily wooded. The watershed is managed by the Chief Forester of the Water Supply Board. The shoreline adjacent to the dam is well-covered with a stand of trees and brush which should preclude sloughing or erosion of shoreline materials. (See photo C-9)

e. Downstream Channel. The downstream channel below the dam is the natural stream bed of the Ponaganset River which leads to the main Scituate Reservoir impoundment a distance of approximately 2,000 feet. Two stream restrictions were noted immediately below the dam. The first is the dry rubble abutment remains of the former highway bridge. These abutment structures have vertical faces 10 feet high and 41.5 feet apart. The second is the existing Ponaganset Road highway bridge waterway openings. This bridge structure has two center piers that form 3 waterway openings of 12 feet wide by 14 feet high each. (See photos C-10, 11, 12)

3.2 Evaluation

Based on the visual inspection, the dam appears to be in GOOD condition, with only minor maintenance items that require attention.

The downstream slope and the upstream shoreline at the left abutment of the dam are supporting vegetal growth. Seepage is emerging from the interface of the embankment and the left abutment. Seepage is exiting through the left training wall of the spillway. The low level gate for the outlet works does not completely close.

Sliding of large blocks of rock from the slope below the spillway crest could partially block the discharge channel and direct the flow against the toe area of the dam near the right abutment. The available drawings indicate the toe wall is founded on soil, not bedrock, and any significant erosion in the toe area could undermine the toe wall. Rotting tree roots and animal holes in the downstream slope can provide paths for seepage, causing erosion and piping of the embankment soils. Large trees growing on the embankment and in the immediate toe area could be uprooted during heavy winds, leaving large depressions. In the upstream face of the dam, such depressions could permit erosion into the crest by wave action. In the downstream toe area, the depressions could cause concentration of seepage and piping. Incomplete riprap protection on the upstream face could lead to erosion into the crest of the dam during times of severe wave action.

SECTION 4

OPERATION AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General

The Barden Reservoir is an operating part of the total Scituate Reservoir system. Barden Reservoir is a tributary reservoir that has a catchment area of 33 square miles or approximately one-third of the Scituate Reservoir drainage basin. Normally, the pool level is unregulated and all water that flows to the main supply pool at Gainer Dam downstream is the result of spillway overflows. Outlet works' gates are operated generally during drought periods to supplement the main pool, during periods of heavy rainfall, to relieve excess loading on the embankment and to lower the pool surface level to implement maintenance work. The outlet conduit at the left abutment of the spillway is used only. The outlet leading to the former mill site has not been used due to seating problems with the gate. Water surface levels are recorded weekly, and the dam is visited daily for spot inspections by watershed personnel.

b. Description of Any Warning System in Effect. Impending storms or intense rainfall are monitored, as a rule, by water department personnel from weather forecasts and the U.S. Weather Bureau (NOAA). During critical periods of high reservoir levels and approaching intense storm activity, both operating and engineering staff are on call and at the site, as needed.

There is no pre-planned warning system for the failure of Barden Reservoir Dam. An Emergency Action Plan must be developed so that operating personnel can notify authorities for mobilization of State or local emergency forces, organize remedial measures to minimize or prevent complete failure when possible, and have an awareness of the locations of supplies, stand-by equipment and materials. Impacted areas need to be defined in order that no time is lost in notification for stand-by or eventual evacuation if need be.

4.2 Maintenance Procedures

a. General

No program of regularly scheduled maintenance has been followed for this dam. Clearing of the vegetation has been infrequent.

b. Operating Facilities

Operational tests of the outlet works' gates are not performed. Rather, the gates are exercised when the pool requires regulation.

4.3 Evaluation

Operations and maintenance procedures for this dam and its appurtenances appear to be infrequent and scheduled during periods of slack time for personnel. Maintenance of the facility is limited. An emergency action plan needs to be formulated and posted to ensure proper and expedient action during critical periods.

weekly basis only. In the correspondence files of the Department of Environmental Management - State of Rhode Island, a peak flow of 2,607 C.F.S. recorded at the site is mentioned.

5.4 Test Flood Analysis. Recommended guidelines for the Safety Inspection of Dams by the Corps of Engineers were used for selection of the "Test Flood". This dam is classified under those guidelines as a SIGNIFICANT hazard structure and SMALL in size. Guidelines indicate a range from the full P.M.F. to one-half the P.M.F. be considered as the test flood value. The watershed has a total drainage area of 33.0 square miles, of which 6.6 square miles (20 percent) is swampy or covered by natural storage ponds. This drainage area is sparsely populated, largely wooded and hilly with rolling terrain. The basin average slope is about 0.035 ft./ft. which can be considered as moderate. A "test flood" equal to one-half the P.M.F. was calculated to be 420 C.S.M., equal to 13,900 C.F.S., and was adopted for this dam. Outflow discharges were also developed using Corps of Engineers' criteria for approximate routing. The outflow discharge for the test flood inflow was 13,240 C.F.S. Design data developed for this investigation is listed in tabular form at the end of this section. The spillway and outlet rating curves are illustrated also in Appendix D. Flood routings were performed assuming a full reservoir pool at the spillway crest level initially.

Calculations indicate that the spillway capacity is hydraulically inadequate to control the "test flood", and overtopping of the dam by approximately 4.4 feet would occur. The inflow and outflow discharge values for this test flood are 13,900 C.F.S. and 13,242 C.F.S., respectively. The maximum outflow capacity of the spillway, in a still reservoir, without overtopping of the dam is 4,654 C.F.S., which is 35 percent of the test flood outflow discharge.

At the spillway crest elevation of 345.1 feet, the capacity of the outlet works structure is 124 C.F.S. It will require 23 hours to lower the reservoir pool level the first foot assuming a surface area of 240 acres. For the 2,618 Ac.-ft. of available storage below the spillway crest, it will require 21 days to drain this reservoir through the existing outlet. One foot of depth in the reservoir at the spillway crest level can approximately accommodate 0.136 inches of effective rainfall. Consequently, it is estimated that overtopping of the dam cannot be eliminated for a "test flood" event if the water level in the reservoir is kept lower than the spillway crest elevation as a safeguard.

5.5 Dam Failure Analysis. An instantaneous full-depth-partial width breach was assumed to have occurred in this dam. This breach will result in an unsteady flow phenomenon with one flood wave travelling up into the reservoir to feed the other wave travelling downstream into the valley.

The calculated dam failure discharge of 22,800 C.F.S. with the impounded water level at the top of the dam (Elevation 352.2) will produce an approximate water surface flood wave elevation of 334.0 feet immediately downstream from the dam. This will raise the water surface about 6.0 feet above the depth just prior to failure when the discharge is 4,654 C.F.S. Estimated downstream water depths due to a possible dam failure discharge of 22,800 C.F.S. may range from 15.0 feet immediately below the dam to 5.0 feet at a downstream distance of 2,000 feet. The failure analysis considered the reach extending from the dam to 2,000 feet downstream. Normal uniform flow, following Manning's formulae, will occur approximately at that point where the rise in the Scituate Reservoir pool is estimated to be 1.35 feet. The failure of this dam may result in damage to the Ponaganset Road and Route 102 bridge structures and temporary disruption of utility services located within their respective rights of way. The Barden Reservoir dam failure may also cause a severe shortage of water to the City of Providence. The dam is therefore classified as a SIGNIFICANT hazard structure.

The failure discharge will diminish as the reservoir is emptied and depth decreased. River valley storage and frictional losses will tend to reduce the discharge and flow velocities also. Water surface elevations due to failure of the dam are computed and are listed in Appendix D.

It is estimated that the maximum depth of flow due to failure of this dam will be 15.0 feet and the maximum velocity will be 43.0 ft./sec.

The calculated dam failure discharge of 22,800 C.F.S. with the impounded water level at the top of the dam (Elevation 352.2) will produce an approximate water surface flood wave elevation of 334.0 feet immediately downstream from the dam. This will raise the water surface about 6.0 feet above the depth just prior to failure when the discharge is 4,654 C.F.S. Estimated downstream water depths due to a possible dam failure discharge of 22,800 C.F.S. may range from 15.0 feet immediately below the dam to 5.0 feet at a downstream distance of 2,000 feet. The failure analysis considered the reach extending from the dam to 2,000 feet downstream. Normal uniform flow, following Manning's formulae, will occur approximately at that point where the rise in the Scituate Reservoir pool is estimated to be 1.35 feet. The failure of this dam may result in damage to the Ponaganset Road bridge and temporarily disrupt the overhead utilities within the right of way of that roadway. The failure wave may also damage Route 102. The Barden Reservoir dam failure may also cause a shortage of water to the City of Providence.

The failure discharge will diminish as the reservoir is emptied and depth decreased. River valley storage and frictional losses will tend to reduce the discharge and flow velocities also. Water surface elevations due to failure of the dam are computed and are listed in Appendix D.

It is estimated that the maximum depth of flow due to failure of this dam will be 15.0 feet and the maximum velocity will be 43.0 ft./sec.

BARDEN RESERVOIR DAM

Inflow, Outflow and Surcharge data

FREQUENCY IN YEARS	24-HOUR TOTAL RAINFALL IN INCHES	24-HOUR* EFFECTIVE RAINFALL IN INCHES	MAXIMUM INFLOW IN C.F.S.	MAXIMUM** OUTFLOW C.F.S.	SURCHARGE HEIGHT IN FEET	SURCHARGE STORAGE ELEVATION
½ PMF	11.9	9.5	13900	13242	11.55	356.6

= Test Flood

* Infiltration assumed as 0.1"/hour
** Lake assumed initially full at spillway crest elevation 345.1.
(top of dam = 352.20)

NOTES:

1. ½ PMF and "test flood" computation based on COE and guidelines.

2. Maximum capacity of the spillway without overtopping the dam (elevation 352.20) is equal to 4,654 C.F.S.

3. All discharges indicated are dependent upon the continued integrity of upstream storage reservoirs.

4. Surcharge storage is allowed to overtop the dam when exceeding the spillway capacity.

5. Test flood = one-half PMF = 420 CSM = 13900 CFS
(D.A. = 33.0 square miles).

6. Above calculated discharge assumes that the outlet works' conduit is closed.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observation. The visual observations did not disclose any evidence of present or past structural instability.

6.2 Design and Construction Data. Plans and cross sections of the dam are shown on a drawing dated 1883. Plans and sections for raising the dam 5 feet are shown on a drawing dated June, 1884. Visual observations indicate the construction of the dam conforms to the plans, except that the crest of the dam is raised 1.5 feet above the top of the upstream masonry wall.

No soils data is available for this dam, and thus the stability analyses could not be performed.

6.3 Post-Construction Changes. Plans dated August 9 and August 15, 1963 indicate that the draw-off structures were repaired and/or replaced at that time.

6.4 Seismic Stability. The dam is located near the boundary between Seismic Zones 1 and 2 and, in accordance with the recommended Phase I guidelines, does not warrant seismic stability analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Based on the visual inspection and review of the available drawings and previous inspection reports, the dam appears to be in GOOD condition. There are several features, however, which adversely affect the future condition of the dam:

1. Hydraulic analysis indicates that the overflow spillway can discharge 4,654 C.F.S. which represents only 35 percent of the test flood outflow which will result in overtopping of the dam by 4.4 feet.

2. Seepage at the toe of the dam at the left abutment.

3. Large protruding blocks of bedrock on the spillway slope below the crest.

4. Rotting tree roots and animal holes on the downstream face.

5. Large trees on the embankment near the left abutment and at the toe of the dam.

6. Incomplete riprap protection on the upstream face.

b. Adequacy of Information. The available information is such that the assessment of the condition of the dam must be based on the visual observations.

c. Urgency. The recommendations and remedial measures described below should be implemented by the Owner within two years after receipt of the Phase I report.

7.2 Recommendations

The following should be accomplished under the direction of a qualified, registered engineer:

1. Conduct further hydrologic and hydraulic studies to determine what alternative measures are necessary to increase the discharge capabilities at the dam and reduce the overtopping potential.

2. Investigate the seepage along the downstream toe between the twin low-level tunnels and the left abutment and recommend measures for monitoring the seepage and/or preventing piping of the embankment soils.

3. Rotting tree stumps on the downstream slope should be removed. The resulting holes, and any animal holes, should be backfilled with appropriate soils.

4. Large trees growing on the crest and in the toe area should be removed and the root holes backfilled.

5. Inspect the spillway under no flow conditions.

6. Repair the gated intake to the former mill in order to increase the drawdown capabilities of the dam.

The Owner should implement any recommendations resulting from the above investigations.

7.3 Remedial Measures

a. Operation and Maintenance Procedures.

1. Brush, vines, and trees on the downstream slope should be cleared, and the vegetation on the slope cut annually thereafter.

2. Riprap on the upstream face should be cleared of vines and brush, and missing riprap replaced.

3. The spillway channel near the right abutment and toe should be inspected on a quarterly basis to check for any blocks of rock which might redirect the spillway flow toward the right toe of the dam.

4. An annual program of technical inspections by a qualified, registered engineer should be instituted.

5. Develop an "Emergency Action Plan" that will include an effective preplanned warning system, reduction of inflows, action to be taken at other reservoirs within the system, locations of emergency equipment, material and manpower, authorities to be contacted, potential areas that require evacuation and reservoir dewatering procedures. The Owner should also provide surveillance of the dam during intense rainfalls.

7.4 Alternatives

There are no alternatives to the recommendations discussed above.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Barden Reservoir Dam DATE October 30,1979

TIME 9:00 A.M.

WEATHER Cool, sunny

W.S.ELEV. 345.36 U.S. _____ D.S.

PARTY :

1.	A. Reed	CE Maguire	6.		
2.	S. Khanna	CE Maguire	7.		
3.	L. Topp	CE Maguire	8.		
4.	E. Dessert	CE Maguire	9.		
5.	F. Leathers	GEI	10.		

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30, 1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	Top of Dam 352.20 feet
Current Pool Elevation	345.36 feet
Maximum Impoundment to Date	Unknown
Surface Cracks	None - one 6" dia. animal burrow noted at Sta. 1+20 on downstream slope.
Pavement Condition	None
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Good (visual only)
Horizontal Alignment	Good (visual only)
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	Free access; no signs of significant trespass
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	Stone wall from Sta 0+00 to 2+49 - Good Riprap from Sta 2+49 to 3+00 - Good, but overgrown with brush. No riprap Sta 3+00 to 3+51 - brush cover only.
Unusual Movement or Cracking at or Near Toe	None observed
Unusual Embankment or Downstream Seepage	Seepage noted at toe at Sta 2+34 - also seepage from joints in stonework on low-level outlet tunnel
Piping or Boils	None observed
Foundation Drainage Features	None observed
Toe Drains	None observed
Instrumentation System	None
Vegetation	Downstream slope covered with heavy brush, trees to 2-in. dia. and numerous rotted stumps to 6 in. dia. Numerous medium and large trees on Dam Sta 2+49 to 3+51. Crest covered with grass.

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30, 1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Not observable - under water
Approach Channel	Reservoir bed
Intake Structure	Inlet at spillway - 1 30 in. dia. cast iron pipe, gated Inlet to old mill complex - gated twin barrel stone masonry culvert

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30, 1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS - GATEHOUSE	Twin box culvert
a. Wood with Granite Block Masonry Foundation	Wooden frame structure on granite masonry foundation
General Condition	Good
Condition of Joints	Good
Spalling	None observed
Visible Reinforcing	None observed
Any Seepage or Efflorescence	None observed
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	None
Cracks	None observed
Rusting or Corrosion of Steel	None observed
b. Mechanical and Electrical	Two manually operated sluice gates within locked gatehouse - not operated during inspection
Air Vents	None
Float Wells	None
Crane Hoist	None
Elevator	None
Hydraulic System	None
Service Gates	Recently replaced but leaking due to poorly designed sluice gate seat
Emergency Gates	None observed
Lightning Protection System	Lightning rod grounded in reservoir
Emergency Power System	None
Wiring and Lighting System	None

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30,1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	No transition 4'-4" x 3'-7½" and 3'-0" x 2'-6" stone masonry box culverts
General Condition	Good

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30, 1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS -SERVICE BRIDGE	Twin culvert gatehouse
a. Super Structure	Wooden bridges linking dam crest with granite base gatehouse; generally in good condition
Anchor Bolts	None observed
Bridge Seat	Granite abutments at either side
Longitudinal Members	Wooden beams appear to be in good condition
Under Side of Deck	Appears to be in good condition
Secondary Bracing	None observed
Deck	Wooden planks appear in good condition
Drainage System	None observed
Railings	Wooden beams appear in fair condition
Paint	Creosote treated
b. Abutment	Granite
General Condition of Masonry	Good
Alignment of Abutment	Good
Approach to Bridge	Dam crest
Condition of Seat and Backwall	Good

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30, 1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	Single 30 in. dia. pipe
a. Concrete and Structural	Wooden gatehouse located atop western spillway abutment
General Condition	Fair
Unusual Seepage or Leaks in Gate Chamber	Sluice gate chamber is a wet well
Cracks	None observed
Rusting or Corrosion of Steel	None observed
b. Mechanical and Electrical	Manually operated sluice gates within both locked gatehouse and locked steel vault successfully operated during inspection.
Air Vents	None
Float Wells	None
Crane Hoist	None
Elevator	None
Hydraulic System	None
Service Gates	Gates are operable and in good condition.
Emergency Gates	None
Lightning Protection System	Lightning rod grounded in water
Emergency Power System	None
Wiring and Lighting System	None

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30, 1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS -TRANSITION AND CONDUIT	30 in. dia. pipe
General Condition of Steel Pipe	Good
Erosion or Cavitation	None observed
Cracking	None observed
Alignment of Monoliths	None observed
Alignment of Joints	None observed
Numbering of Monoliths	None observed

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30, 1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Twin low-level outlet tunnels and low-level 30-in. dia. cast iron pipe
General Condition of Concrete	Stone masonry in good condition on visible surfaces. Cast iron pipe and interior of tunnels not visible
Rust or Staining	None observed
Spalling	None observed
Erosion or Cavitation	None observed
Any Seepage or Efflorescence	Not discernible
Condition at Joints	Good
Drain Holes	Seepage through roof and walls of twin outlet culverts and wing walls
Channel	Inspected by CEM
Loose Rock or Trees Overhanging Channel	Inspected by CEM
Condition of Discharge Channel	Inspected by CEM

PERIODIC INSPECTION CHECK LIST

PROJECT Barden Reservoir Dam DATE October 30, 1979

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS- SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Several 2 to 6-in. trees overhanging bank on east side of channel, upstream of masonry wall.
Floor of Approach Channel	Not observed - under water
b. Weir and Training Walls	
General Condition of Concrete	Stone masonry in good condition with slight erosion behind downstream end of east training wall.
Rust or Staining	None observed
Any Seepage or Efflorescence	None
Drain Holes	None observed
c. Discharge Channel	Bedrock slope below spillway crest directs water into natural streambed.
General Condition	Good
Loose Rock Overhanging Channel	Several large protruding blocks of bedrock on slope below spillway channel.
Floor of Channel	Exposed ledge in spillway channel below weir shows slight seepage at joints in rock.
Other Obstructions	Bedrock outcrop and blocks of granite in streambed 100-200 ft. downstream of dam, abandoned bridge abutments about 350 ft. downstream, existing bridge and abutments about 450 ft. downstream.

APPENDIX B

ENGINEERING DATA

APPENDIX B-1

Correspondence pertaining to the history, maintenance, and modifications to the Barden Reservoir Dam as well as copies of past inspection reports are located at:

Department of Environmental Management
State of Rhode Island
83 Park Street
Providence, Rhode Island 02903

Providence Water Supply Board
552 Academy Avenue
Providence, Rhode Island 02903

APPENDIX B-2

Selected Copies of Past Inspection Reports

PHJ

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

DAM INSPECTION REPORT

DAM: #164 RIVER: Ponagansett River WATERSHED: Pawtuxet (X P) DATE: 6 July 1978

NAME: Barden Reservoir TOWN: Scituate INSPECTED BY: Earle F. Prout, Jr.

OWNER: City of Providence
c/o Water Supply Board
552 Academy Avenue
Providence, RI

OTHER INTERESTED PARTY: --

REASON FOR INSPECTION: N.P.S.I.D. - Low/Intermediate Hazard; Annual Inspection

* * * * * * * * * *

REPORT:

General - Date Built: 1884
Date of Last Inspection: May, 1946

Earthen Dam Embankment - has a concrete core extending northwesterly, approx. 290 feet from the abutment wall of the spillway to where it meets and joins the natural slope of the terrain. The water elevation of the pool is full but with only a trickle of water flowing over the crest of the spillway. The pond side of the embankment, originally lined with rip-rap, is currently retained by a mortared masonry wall which appears to be structurally stable (photo #1). The downstream slope is mostly overgrown with low shrubs and small trees (photos #4 & #6). The crest, which is flat and approx. 20 feet wide, is clear along the entire length and has no signs of erosion or wash-out of top soil (photo #4). Because of the heavy growth of low vegetation on the downstream slope, it was impossible to determine, with any validity, the extent of any trespass of burrowing animals. There are also no indications of seepage or leakage through the embankment or at the abutting masonry walls of the spillway.

Gate Structure - The approach to both control structures is clear and unobstructed. A close inspection of the front (or pond side) of the center gate structure was not possible because of inaccessability to that side of the building due to its design and construction (photo #5). The gatehouses are of wooden frame construction on mortared masonry foundation. Both structures appear to be in good structural condition. However some of the wooden shingles on both have been torn off. The asphalt roof shingles are also beginning to tear (or be torn) off both structures. Some preventive maintenance is suggested. Only one of the two gates at the center structure is currently open and passing a small amount of water into former headrace. The former raceway is lined with masonry and is heavily overgrown with vegetation and overhanging trees along the banks (photo #7).

DAM INSPECTION REPORT (Continued) Dam #164 - Barden Reservoir

Spillway - The granite block spillway, with large monolithic granite blocks across crest and mortared masonry face, appears to be structurally sound and in generally good condition. The approach to the spillway is clear and unobstructed. There is no spalling, scouring, or other visible signs of deficiencies. The abutment walls on both sides of spillway are of mortared masonry blocks and appear to be in good condition. The natural ledge outcropping and large granite blocks in stream below the spillway form a natural stilling pool and energy dissipator during periods of full flow. The downstream channel is formed by natural ledge and masonry walls to at least beyond the bridge. Some small shrubs are growing in the center of the stream; but otherwise, the river is free of debris and fallen trees (photo #6).

Comments/Recommendations - The dam is in generally very good condition. It is suggested, however, that a confirming letter of inspection to the owner request that the trees and shrubs along the downstream slope of the embankment be removed before becoming a major problem. Also, some maintenance should be performed on both gate-houses before a rotting condition developes.

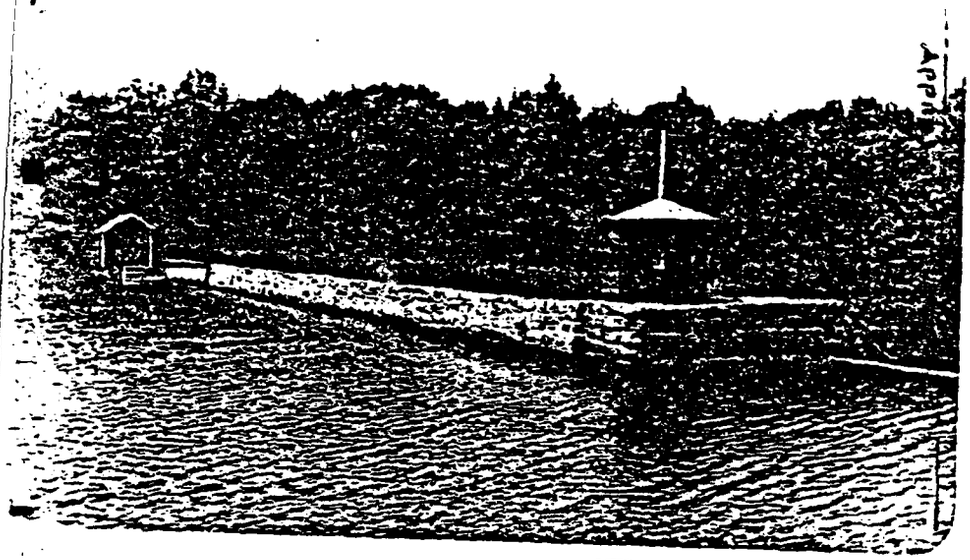


PHOTO #1.

General view of upstream face of dam embankment, showing both gatehouses and mortared masonry wall.

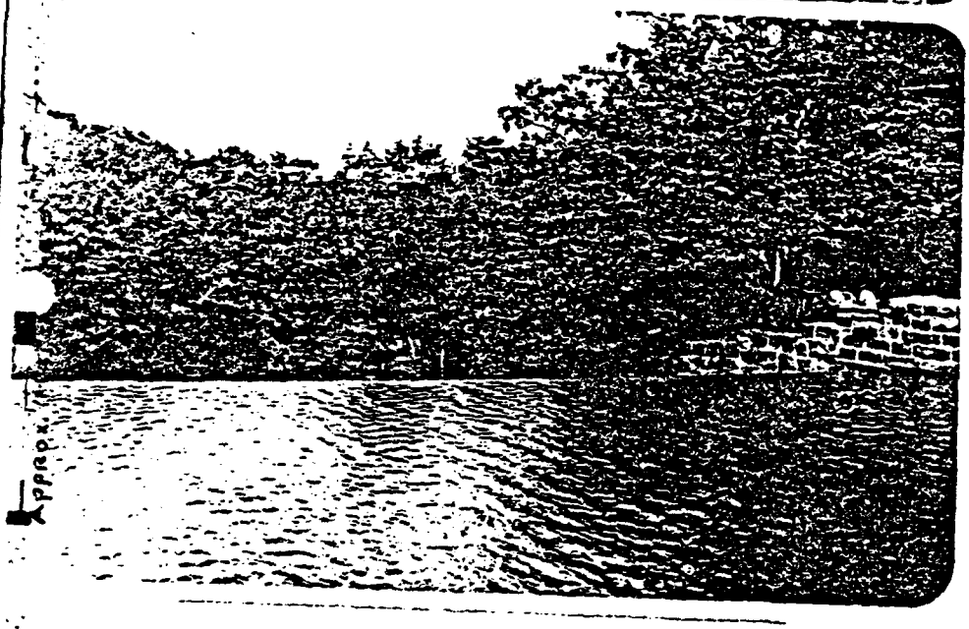


PHOTO #2.

General view across crest of spillway. No significant irregularities noticeable across entire crest.

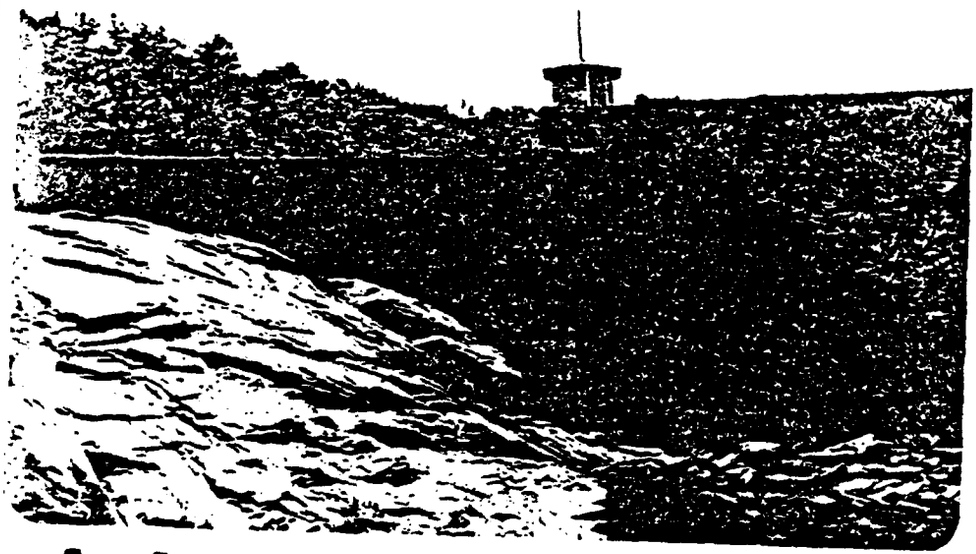


PHOTO #3.

General view of face of spillway, heavy masonry abutment wall & ledge outcropping.

Only a trickle of water passing over spillway this date.

DAM #164
Barden Reservoir

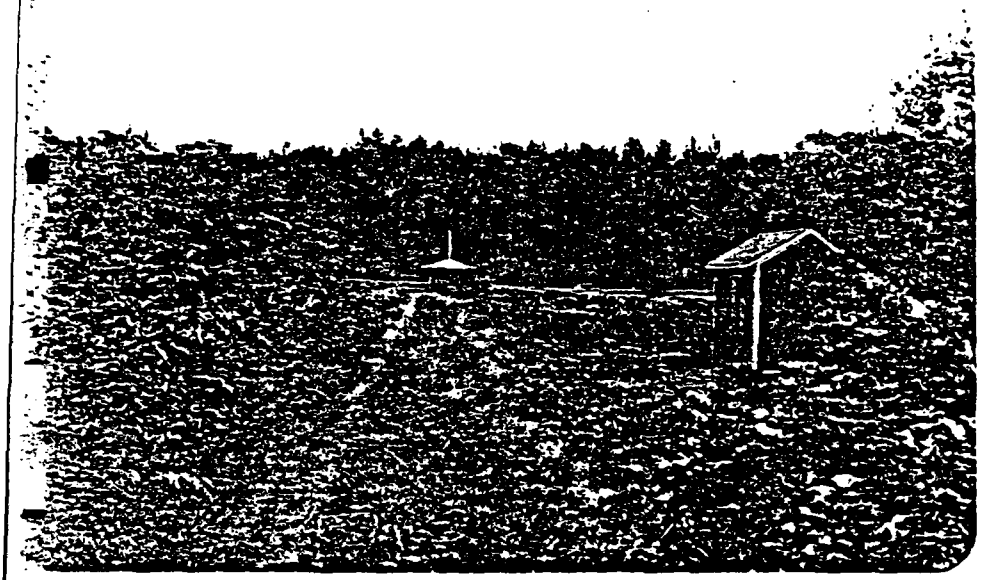


PHOTO #4.

General view of top of dam embankment showing both gatehouses and extent of growth of vegetation. View is toward spillway.

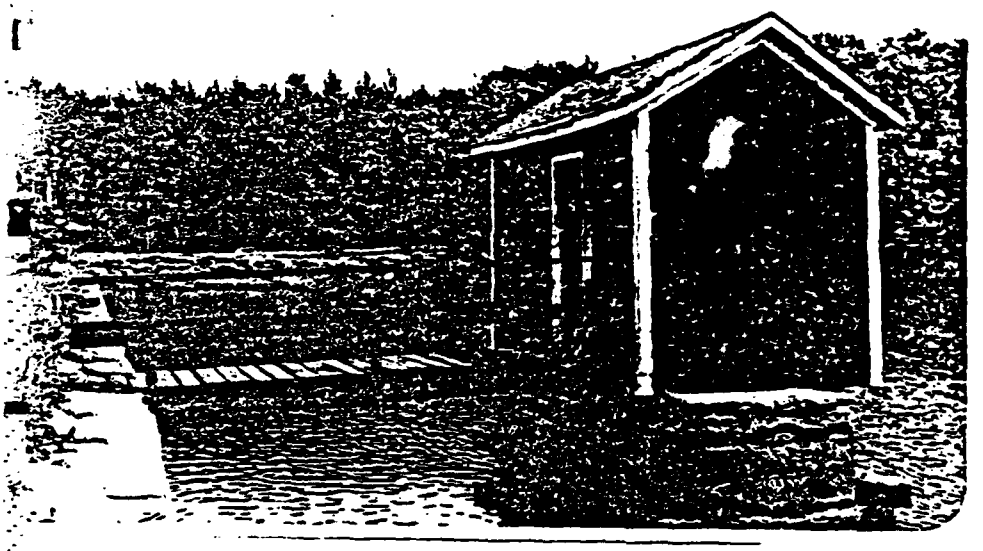


PHOTO #5.

View of gatehouse in center of dam embankment. Acess bridge appears to be of recent construction and in good condition.

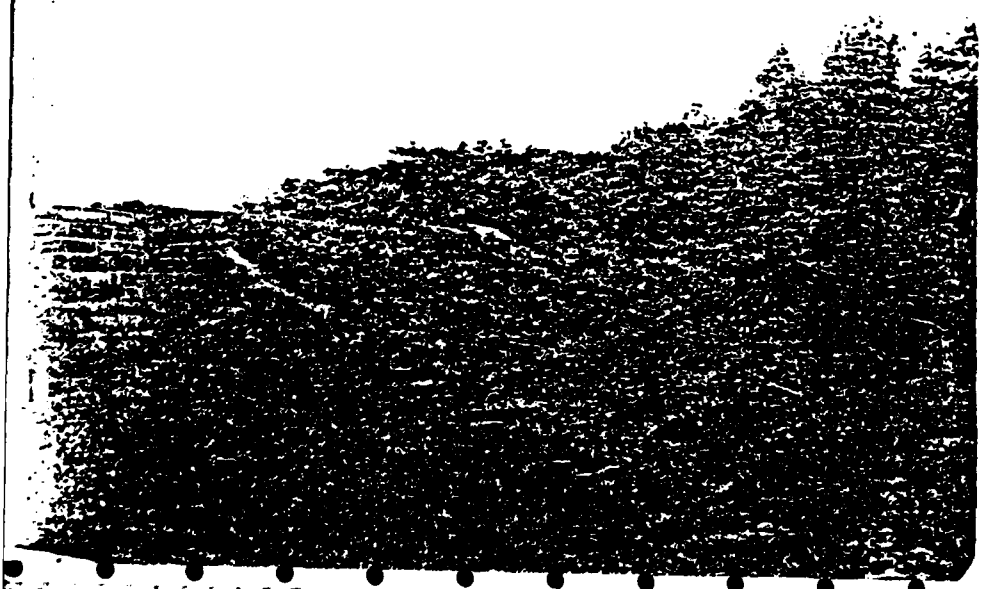


PHOTO #6.

General view of heavy masonry abutment wall adjacent to spillway. (Also showing partial view of downstream slope of dam embankment.

DAM # 164

Barden Reservoir

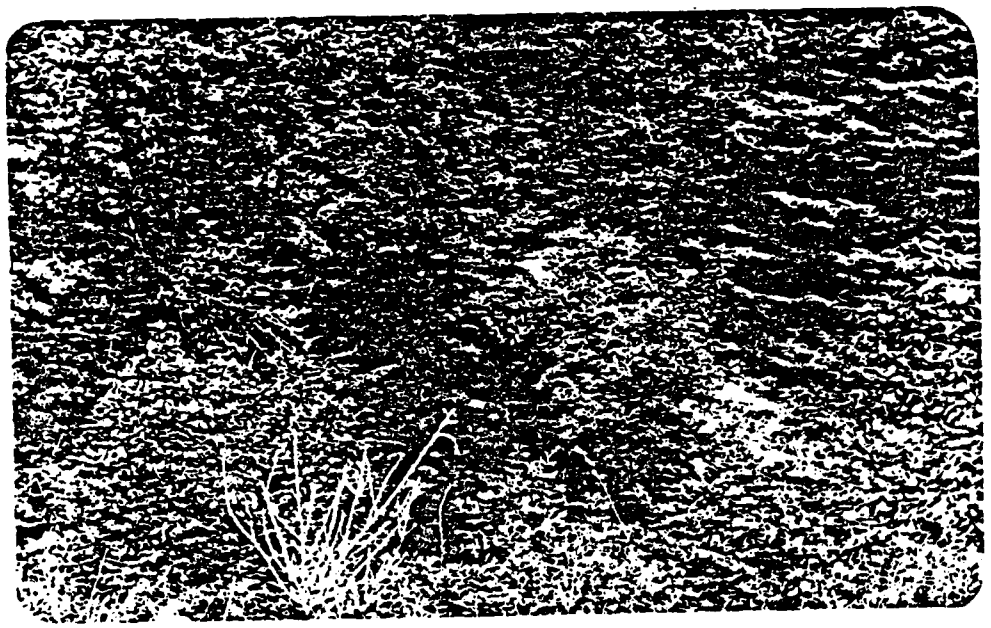


PHOTO #7.

Looking downstream at former headrace to former mills. Minor amount of water passing through one gate on this date.

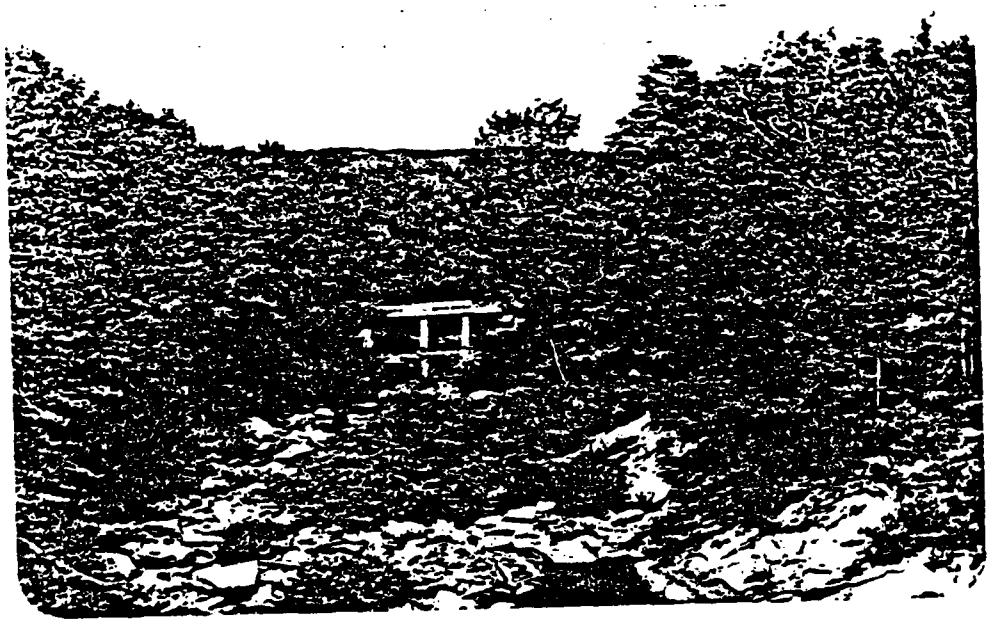


PHOTO #8.

General view looking downstream from spillway area.

DAM # 164
Barden Reservoir Dam

DIVISION OF HARBORS AND RIVERS

SURVEY OF DAMS IN RHODE ISLAND

Pawtuxet River Basin (North Branch) #164 Barden Res.

Drainage Area 33.0 sq. mi.

February 1948

Spillway ?

Estimated extreme freshet 2607 c.f.s.

FEBRUARY 1948

R. I. DEPARTMENT OF PUBLIC WORKS
DIVISION OF HARBORS AND RIVERS

SPECIAL INSPECTION REPORT

DAM NO. 164

INSPECTED BY J. V. KEILY

TOWN - SCITUATE

DAM NO 164 NAME BARDEN RESERVOIR ON ~~BROOK~~ RIVER PONAGANSETT RIVER ~~TRENCH~~ WATERSHED PAWTUXET N 3

OWNER PROVIDENCE WATER SUPPLY BOARD

ADDRESS 161 FOUNTAIN STREET, PROVIDENCE. TEL. ~~GE 6541~~ JA 6300

REPORT ON—NEW CONSTRUCTION ~~REPAIRS~~ INSPECTION ONLY X

PLANS BY APPROVED CONTRACTOR

TICKLER

SPILLWAY
TYPE
CONDITION

DRAW-OFF GATES
NUMBER
CONDITION

TRENCHES & WHEELS

EMBANKMENT
TYPE
CONDITION

APPROACHES

EROSION

BRUSHES & TREES

RIPRAP

PRESENT USE

WHO CONTROLS

WHO CONTACTED AT SITE

INSTRUCTIONS LEFT

IN EMERGENCY CALL

INSPECTION REPORT BY JOHN V. KEILYREASON ROUTINE DATE 5/23/46

EMERGENCY?

1. PHILIP J. HOLTON, CHIEF ENGR., 199 ROCHAMBEAU AVE., PROVIDENCE, R.I. TEL. PL 7354
2. ALLEN RATHBURN, ASST ENGR., SCITUATE, R.I. TEL. VA 8041 & VA 1614

5/23/46 CONDITION GOOD

EXTENSIVE RESERVOIR; BUILT 1883-4; EARTH DAM WITH HEAVY ASHLAR MASONRY ON POND SIDE; 16' TOP WIDTH AND ONE ON ONE AND ONE-HALF GRASSED SLOPE ON DOWN STREAM SIDE; MAXIMUM HEIGHT APPROXIMATELY 35 FEET; CONDITION GOOD; GATES IN WORKING ORDER AND UNDER COMPETENT SUPERVISION. SQUARED GRANITE MASONRY AROUND ABUTMENTS AND SPILLWAY NEEDS POINTING.

R. I. DEPARTMENT OF PUBLIC WORKS
DIVISION OF HARBORS & RIVERS

164

OFFICIAL INSPECTION REPORT

DATE: 5/22/46

INSPECTED BY: JK

DAM NO. 164 NAME: Barden Reservoir ~~BROOK RIVER TRENCH~~ Pomagansett River

TOWN OR CITY Scituate (near Rockland) ON PNC (Pomagansett River) WATERSHED

OWNER P.W.S.B. ADDRESS: 161 Fountain St, Prov R.I.

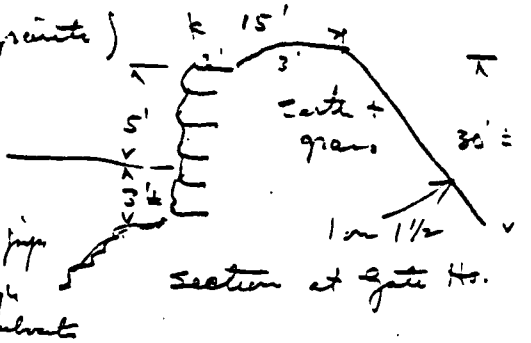
IN EMERGENCY CALL (1) " ADDRESS: " TEL.NO. De 8-5

(2) ADDRESS: TEL.NO.

(3) ADDRESS: TEL.NO.

SPILLWAY—TYPE Masonry - painted - on ledge (granite)

CONDITION: See sketch | Excellent



DRAW-OFF GATES—NUMBER 3 total (1 - at spillway : 30" Cl. pipe
2 - thru Embankment : 4'x5' high stone culvert

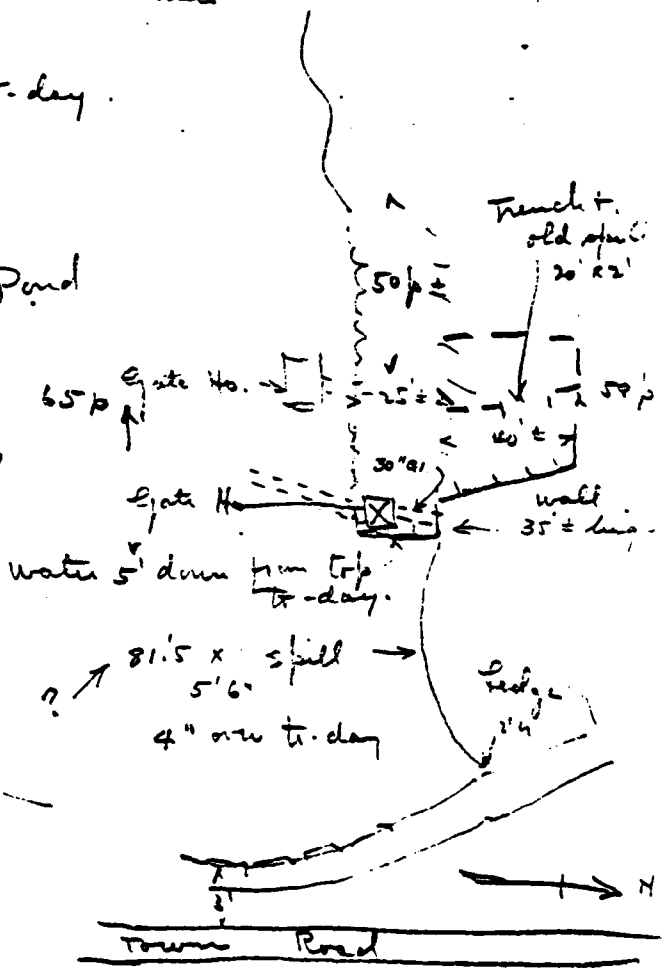
CONDITION:

Appear tight -
30" Cl. Pipe open 2" to-day.

TRENCH GATES—NUMBER None.

CONDITION X

Pond



EMBANKMENT Earth - St. Wall Pond Side
Squared granite - painted

CONDITION: Excellent - Needs some pointing

APPROACHES OK - Treated + greased

EROSION None

BRUSH & TREES Small - D.S. Slope

RIP-RAP Wall - Good Condition.

R. I. DEPARTMENT OF PUBLIC WORKS
DIVISION OF HARBORS & RIVERS

OFFICIAL INSPECTION REPORT

DATE: 5/23/46

INSPECTED BY: JOHN V. KEILY

DAM No. 164 NAME: BARDEN RESERVOIR ~~BROOK~~ RIVER PONAGANSETT RIVER

TOWN OR CITY SCITUATE (NEAR ROCKLAND) ON PNB WATERSHED JA 6300

OWNER PROVIDENCE WATER SUPPLY BOARD, 161 ADDRESS: 161 FOUNTAIN STREET, PROVICENCE, R. I. ~~BE 6311~~

IN EMERGENCY CALL (1) PROVIDENCE WATER SUPPLY BOARD ADDRESS: SAME AS ABOVE TEL. NO. JA 6300

(2) Phillip J. Holton, Chf. Engr. ADDRESS: 199 Rochambeau Av, Prov. TEL. NO. PR 7355

(3) Allen Rathbun, Asst. " ADDRESS: Scituate TEL. NO. Va 0[illegible]

SPILLWAY—TYPE MASONRY; POINTED; ON LEDGE (~~BOULDER~~ Granite) (SEE SKETCH)

CONDITION: EXCELLENT

DRAW-OFF GATES—NUMBER 3 TOTAL; 1 AT SPILLWAY—30" C I PIPE; 2 THROUGH EMBANKMENT 4'x5' HIGH; APPARENTLY TIGHT.

CONDITION: 30" C I PIPE OPEN 2" TO-DAY

TRENCH GATES—NUMBER None

CONDITION X

EMBANKMENT EARTH ; STONE WALL POND SIDE; SQUARE GRANITE AND POINTED

CONDITION: EXCELLENT; NEEDS SOME POINTING. ~~WATER OB DOWN FROM TOP TO-DAY~~

APPROACHES OK. NATURAL AND GRASSED.

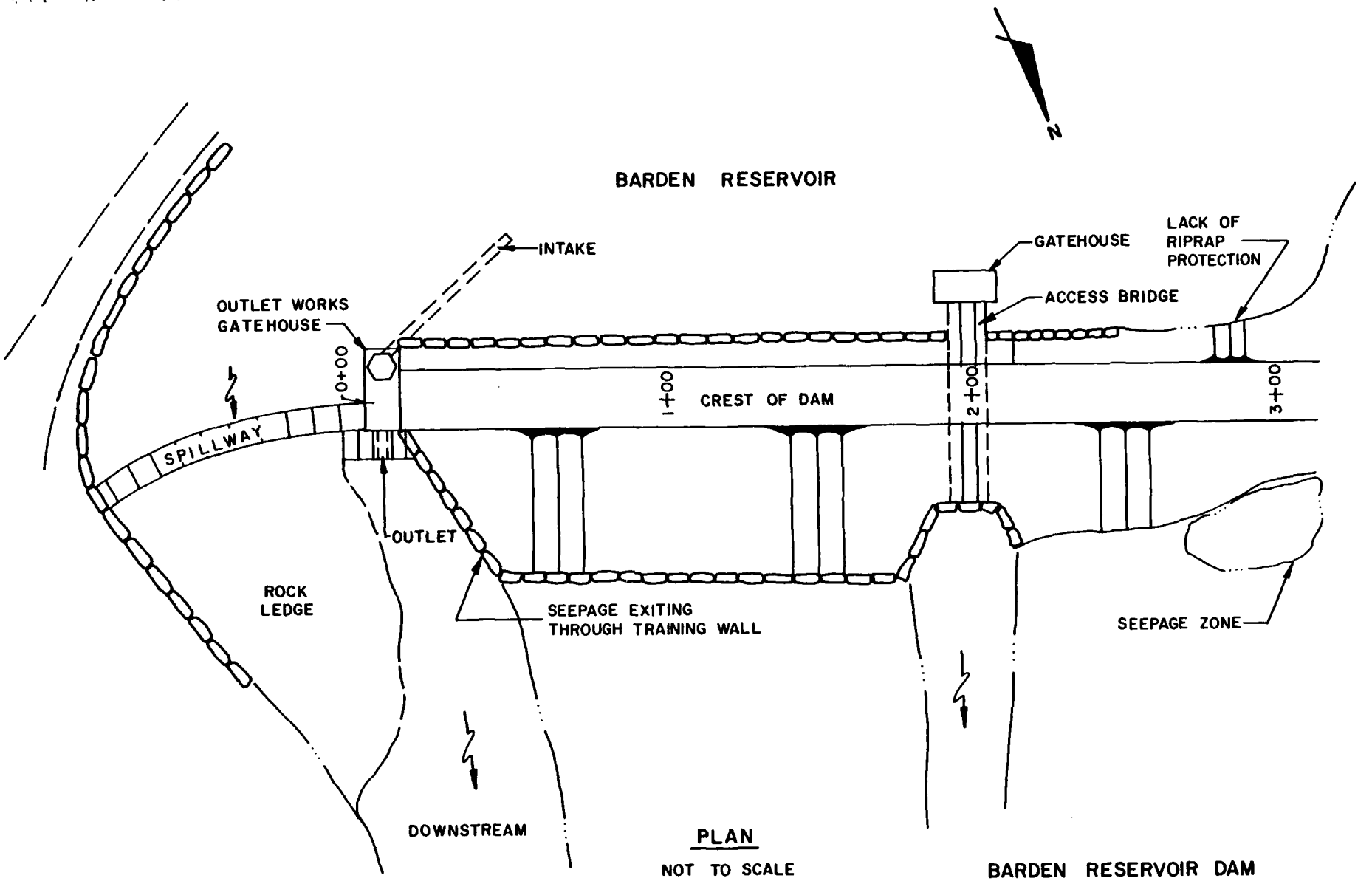
EROSION NONE

BRUSH & TREES SMALL ON DOWN SIDE SLOPE

RIP-RAP WALL; GOOD CONDITION.

APPENDIX B-3

PLANS, SECTIONS DETAILS



BARDEN RESERVOIR DAM
GENERAL PLAN

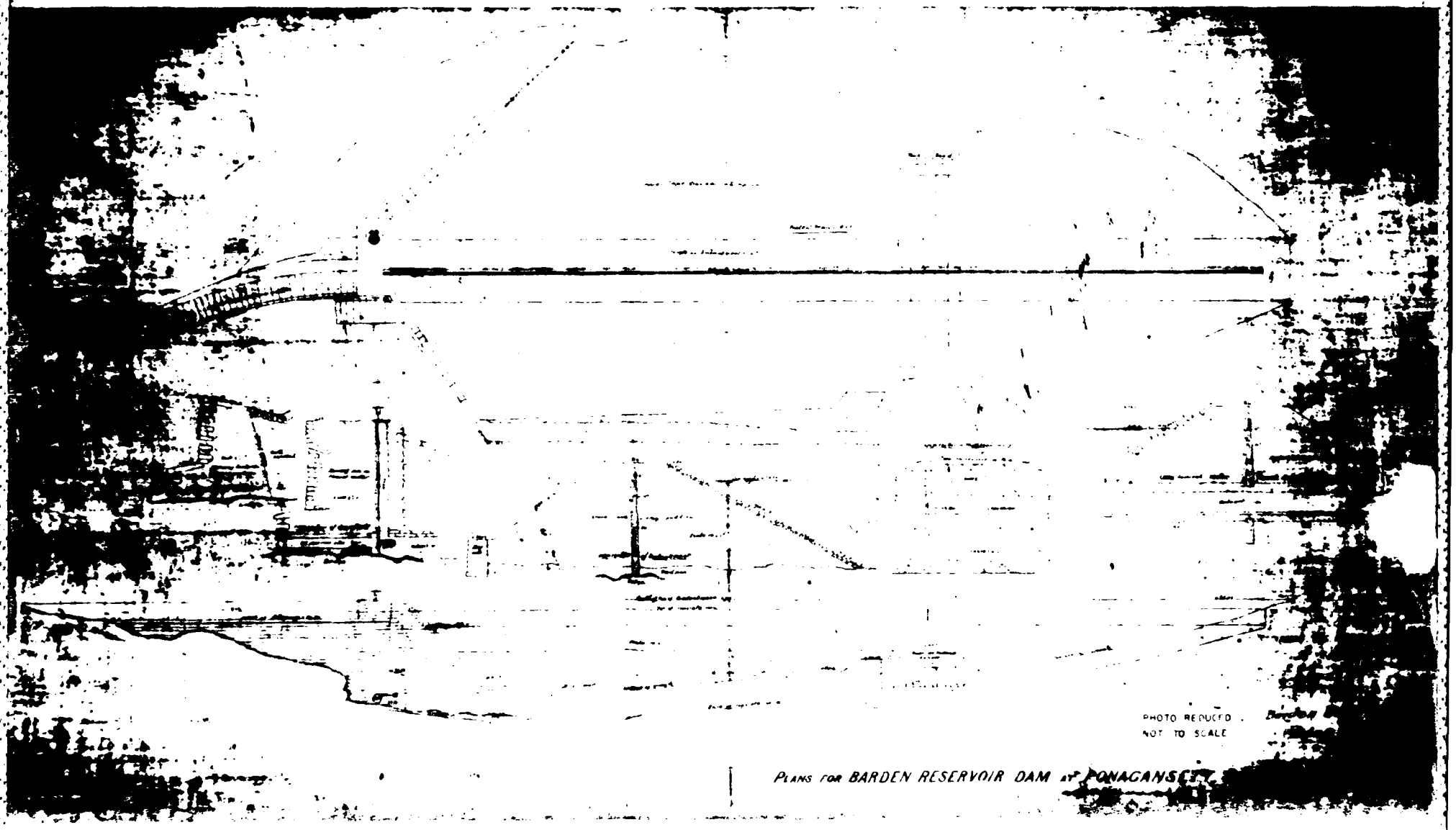
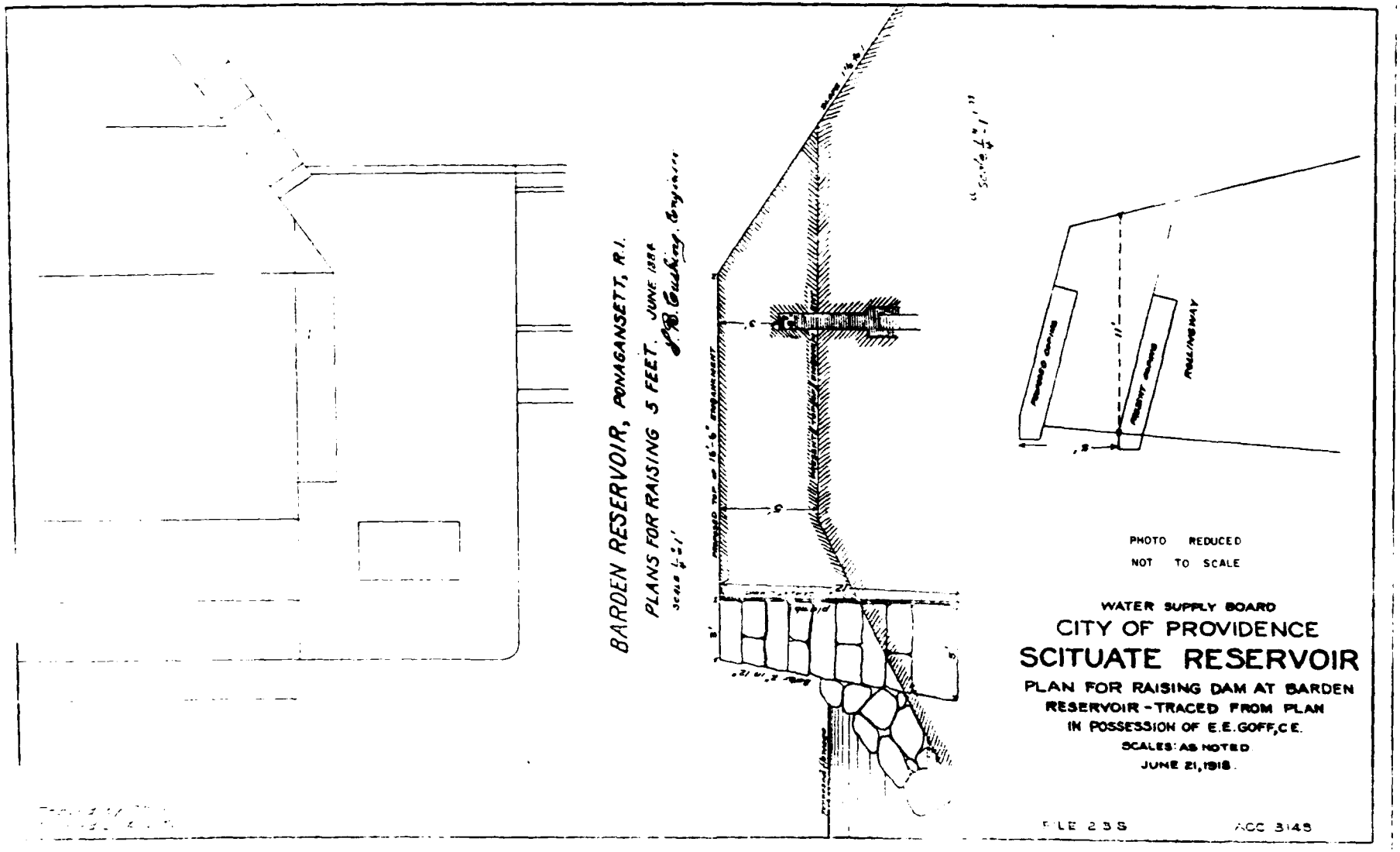
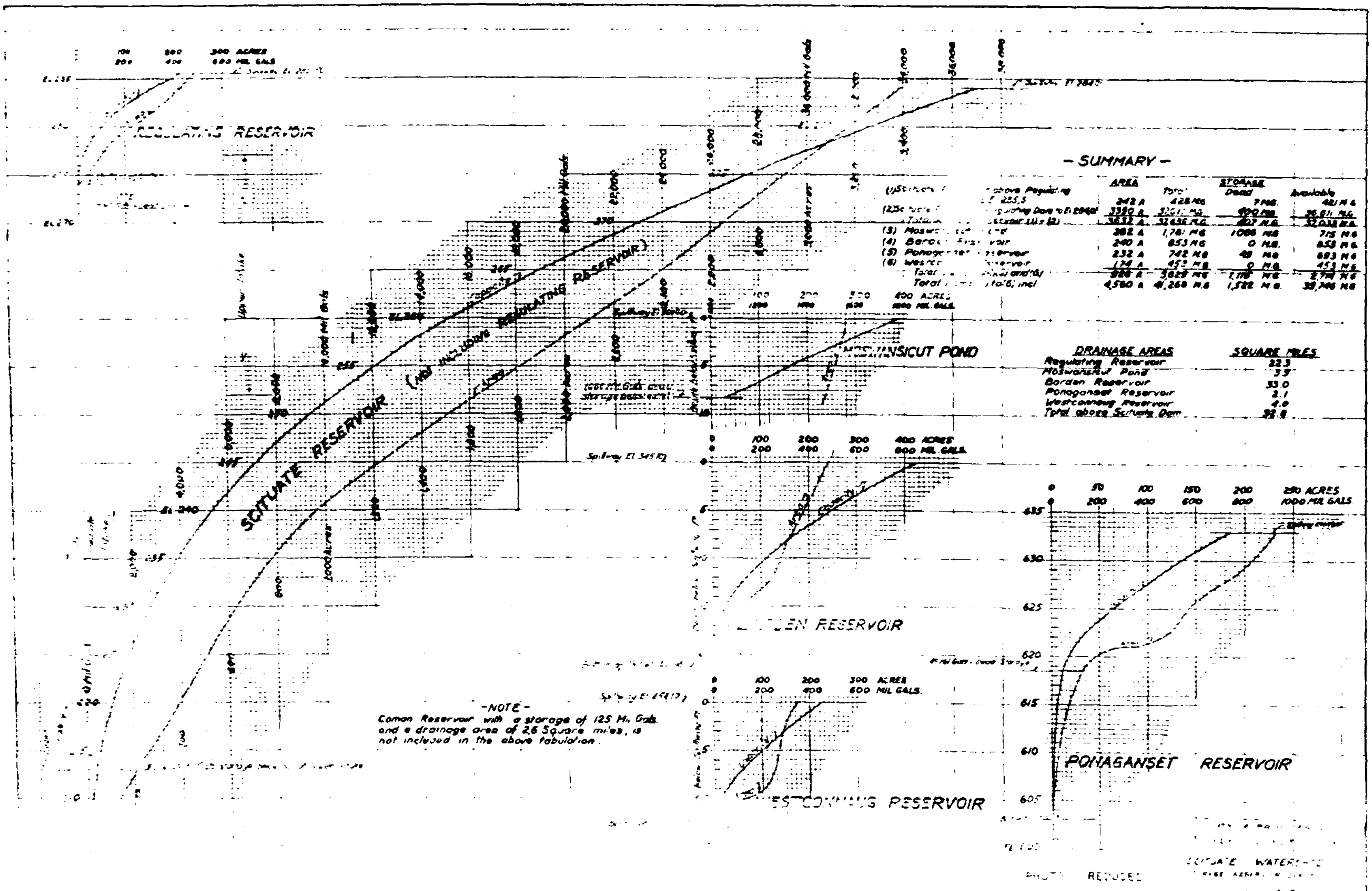


PHOTO REDUCED
NOT TO SCALE
PLANS FOR BARDEN RESERVOIR DAM at PONAGANSET

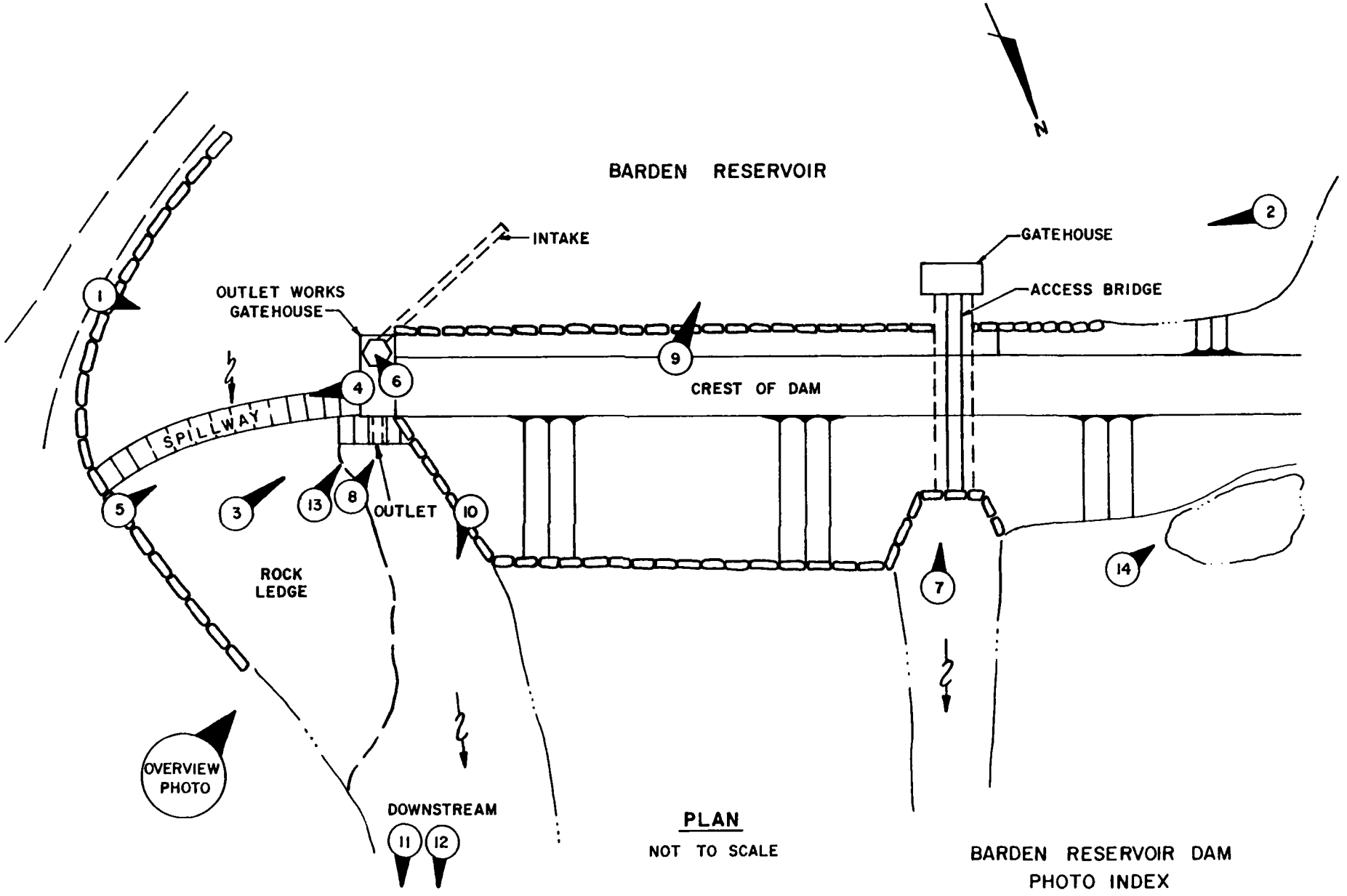

BARDEN RESERVOIR, PONAGANSETT, R.I.
PLANS FOR RAISING 5 FEET. JUNE 1888
W.B. Gushing, Engineer.
PRESENT DAM
PROPOSED DAM
PUBLIC WAY
PHOTO REDUCED
NOT TO SCALE
WATER SUPPLY BOARD
CITY OF PROVIDENCE
SCITUATE RESERVOIR
PLAN FOR RAISING DAM AT BARDEN
RESERVOIR - TRACED FROM PLAN
IN POSSESSION OF E.E. GOFF, C.E.
SCALES: AS NOTED
JUNE 21, 1918.
FILE 235
ACC 3145



REGULATING RESERVOIR
SCITUATE RESERVOIR (Not including Regulating Reservoir)
- SUMMARY -
AREA
Total
STORAGE
Dead
Available
242 A 428 MG 7 MG 421 MG
3390 A 400 MG
3632 A 32,436 MG 407 MG 32,032 MG
(3) 382 A 1,781 MG 1066 MG 715 MG
(4) 240 A 853 MG 0 MG 853 MG
(5) 232 A 742 MG 48 MG 693 MG
(6) 174 A 453 MG 0 MG 453 MG
Total 4,560 A 41,268 MG 1,522 MG
MOSWANSICUT POND
DRAINAGE AREAS
SQUARE MILES
Regulating Reservoir 22.3
Moswansicut Pond
Borden Reservoir 53.0
Ponaganset Reservoir 2.1
Westconnaug Reservoir 4.0
Total above Scituate Dam
-NOTE-
Comon Reservoir with a storage of 125 Mil. Gals. and a drainage area of 2.6 Square miles, is not included in the above tabulation.
PONAGANSET RESERVOIR
PHOTO REDUCED
SCITUATE WATERSHED

APPENDIX C

PHOTOGRAPHS



PLAN

NOT TO SCALE

BARDEN RESERVOIR DAM
PHOTO INDEX

PHOTO C-1 - Upstream Face of Dam looking from Right Abutment Area.

PHOTO C-2 - Upstream Face of Dam looking from Left Abutment Area.

PHOTO C-3 - Downstream Slope of Dam looking from Right Abutment Area.

PHOTO C-4 - Overflow Spillway looking toward Right Abutment.

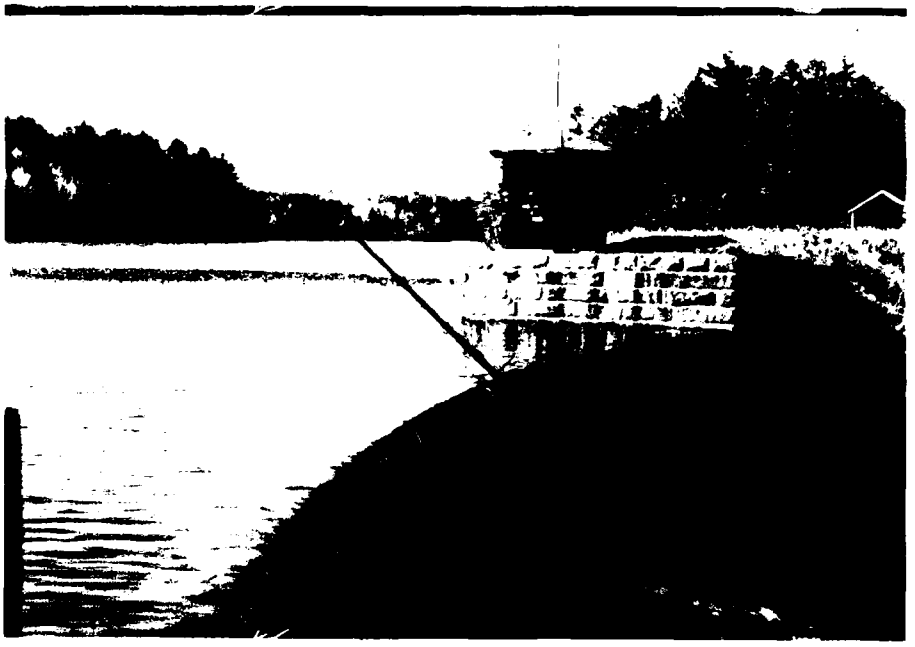


PHOTO C-5 - Overflow Spillway looking from Right Abutment Area.

PHOTO C-6 - Sluice Gate Control Mechanism for Outlet Works near Left Abutment of Dam.

PHOTO C-7 - Stone Masonry Box Culvert Outlet for Gatehouse at Left Abutment of Dam.

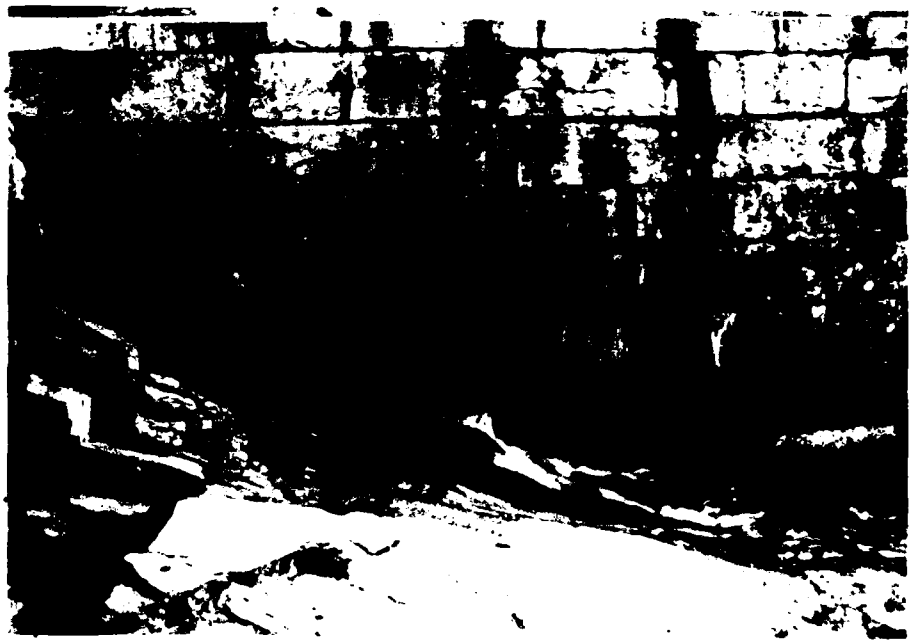


PHOTO C-8 - Thirty-inch Cast Iron Outlet Conduit Adjacent to Spillway.

PHOTO C-9 - View of Reservoir from Dam.

PHOTO C-10 - Downstream Channel Below Dam.

PHOTO C-11 - Ponaganset Road Bridge Downstream from Dam.

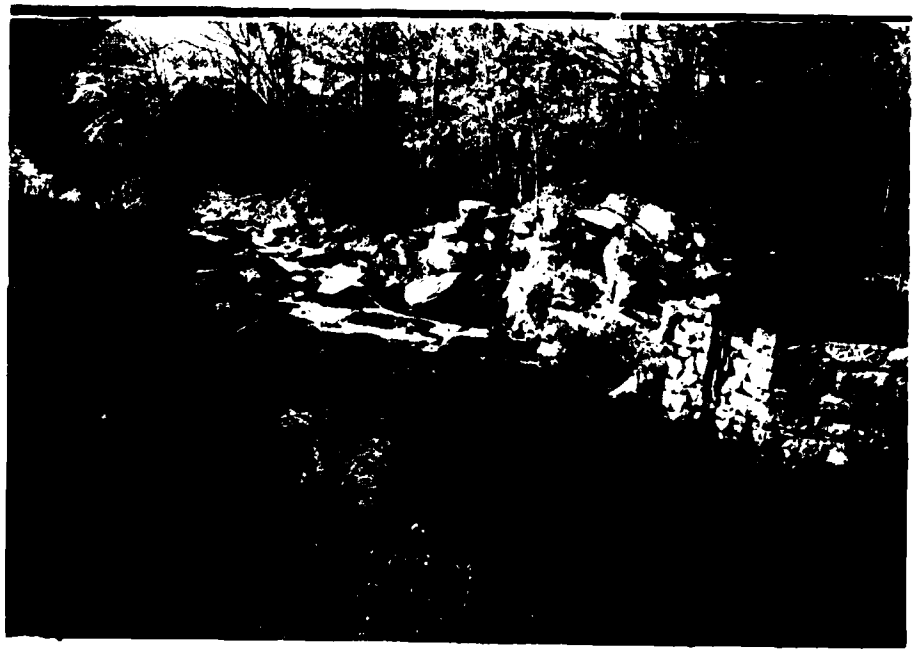


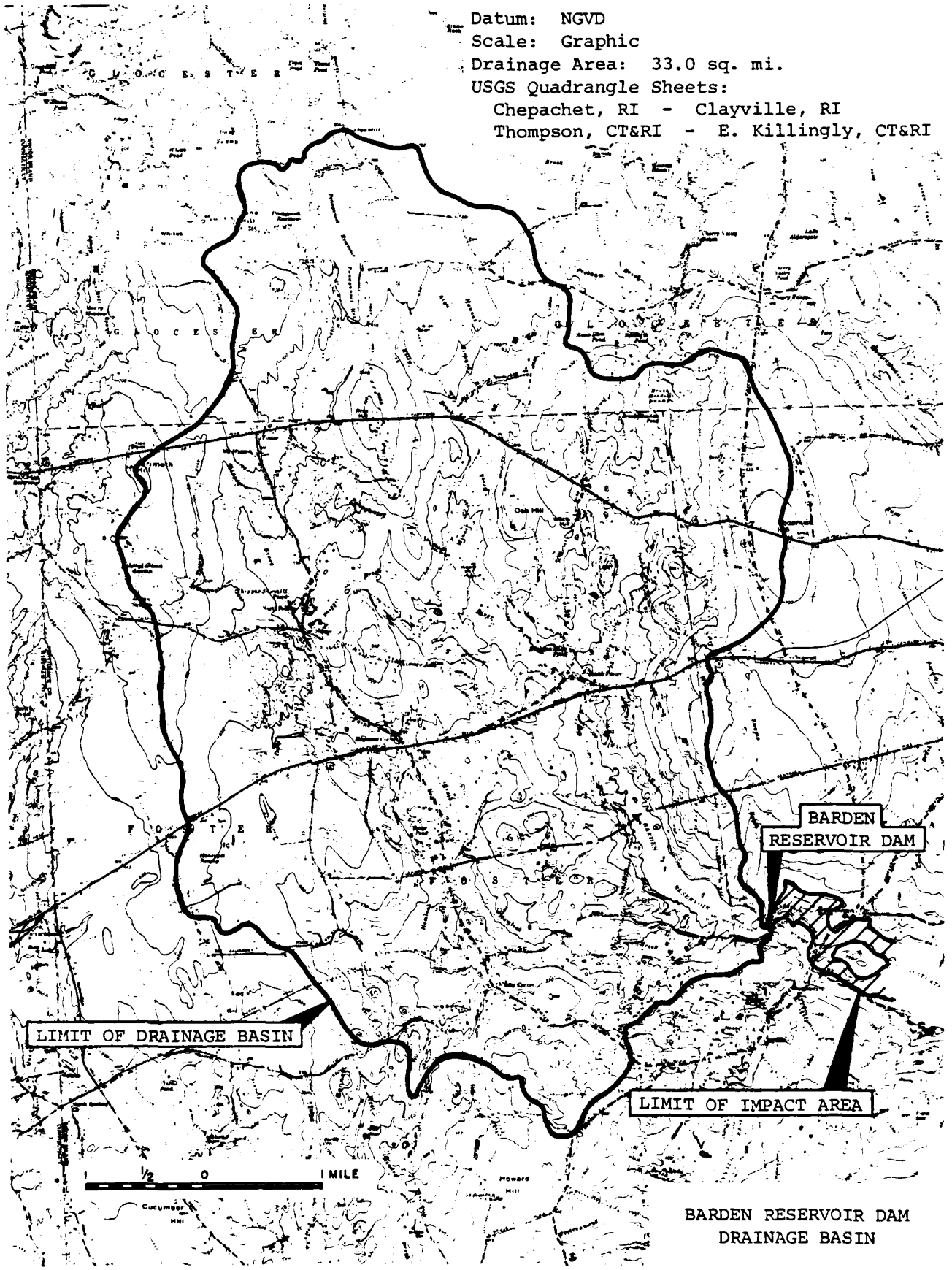
PHOTO C-12 - Ruins of Former Highway Bridge just upstream from Photo C-11.

PHOTO C-13 - Seepage through masonry training wall at left abutment of spillway.

PHOTO C-14 - Seepage at Left Abutment of Dam Embankment.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



BARDEN RESERVOIR DAM
DRAINAGE BASIN

PLATE D-1

A. Size Classification — Barden Reservoir Dam

Height of dam = 35.0 ft.; hence SMALL

Storage capacity at top of dam (elev. 352.2) = 4322 AC-FT.; hence INTERMEDIATE

Adopted size classification INTERMEDIATE

B. Hazard Potential

The dam failure discharge may damage the Ponaganset Road Bridge and temporarily disrupt the overhead utilities that are adjacent to the road. The failure wave may also damage Route 102. The rise in water surface elevation in the Scituate Reservoir due to failure of Barden Reservoir Dam is estimated to be 1.35 feet.

C. Adopted Classifications

HAZARD	SIZE	TEST FLOOD RANGE
SIGNIFICANT	INTERMEDIATE	Half PMF to the Full PMF

Adopted Test Flood = Half PMF = 420 CSM

= 13900 CFS

D. Overtopping Potential

Drainage Area = 33.0 sq. miles

Spillway crest elevation = 345.1 NGVD

Top of Dam Elevation = 352.2 NGVD

Maximum spillway discharge Capacity without overtopping of dam = 4654 CFS

"test flood" inflow discharge = 13900 CFS

"test flood" outflow discharge = 13242 CFS

% of "test flood" overflow carried by spillway without overtopping = 35%

"test flood" outflow discharge portion which overflows over the dam = 8588

% of test flood which overflows over the dam = 65%

Estimating Maximum Probable Discharges - Inflow and Outflow Values Date of Inspection: October 30,1979

Name of Dam Barden Reservoir Dam ; Location of Dam Upstream of Scituate Res. ; Town Scituate, R.I.

Watershed Characterization Swampy with natural storages upstream; moderate slopes ; 6.6sq. miles of drainage area is swampy or occupied by storage reservoirs

Adopted "test" flood = Half PMF = 420 CSM = 13900 CFS; Re = Effective Rainfall = 9.5 inches

D.A. = Drainage Area (Gross) = 33.0 Square Miles; Basin Slope = 0.02-0.05 hence; moderate

S.A. = Surface Area of Reservoir = 0.375 Square Miles; Time of Concentration=More than three hours

Shape and Type of Spillway = Overflow; curved, vertical fall; broad crested, granite stone

B = Width of Spillway = 82.0 feet; C = Coefficient of Discharge = (3.09-Friction) = 3.00 .

Maximum Capacity of Spillway Without Overtopping = 4654 CFS = 35 % of test flood outflow

Top of Dam Elevation = 352.20 ; Spillway Crest Elevation = 345.10

Overflow portion of Length of Dam = 351 ; C = Coefficient of discharge for Dam = 2.60

Name of Dam	Test Flood Q_p		Inflow Characteristics		Outflow Characteristics First Approximation			Outflow Characteristics Second Approximation			Outflow Characteristics Third Approximation (Adopted)		
	CSM	CFS	h_0 in feet	S_0 in in.	Q_{p1} CFS	h_1 in ft.	S_1 in in.	S_2 in in.	h_2 in ft.	Q_{p2} CFS	S_3 in in.	h_3 in ft.	Q_{p3} CFS
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Barden Reservoir Dam	100 Year	6700	9.03	1.23	-	-	-	-	-	-	1.19	8.74	6574
	½PMF =420	13900	14.68	2.00	-	-	-	-	-	-	1.57	11.55	13242

Q_p = Discharge; h= Surcharge height; S = Storage in inches

NOTE: Outflow discharge values are computed as per COE guidelines.

Name of Dam: Barden Reservoir Dam

Estimating Effect of Surcharge Storage on "Test Flood"
[Routing of Flood Through Reservoir]

The routing of floods through the reservoir was carried out according to guidelines established by the Corps of Engineers in Phase-1 Dam Safety Investigations issued March, 1978.

Formulae used were the following for peak inflow = Q_{p1} in C.F.S.

Surcharge height to pass Q_{p1} in feet = $h_1 = \left[\frac{Q_{p1}}{CB}\right]^{2/3}$ ----------(1)

Surcharge storage in inches for surcharge height $h_1 = S_1 = \frac{S.A \times h_1 \times 12}{D.A}$ ---(2)
where S.A = surface area in square miles
where D.A = drainage area in square miles

$$Q_{p2} = Q_{p1}\left[1 - \frac{S_1}{\text{Total Effective Rainfall}}\right] \text{----------(3)}$$

First Approximation

Test flood inflow = Half PMF = Q_{p1} = 13900 C.F.S.

h_1 = 14.68 feet

S_1 = 2.00 inches

Final Approximation

Test flood outflow = Q_{pfinal} = 13242 C.F.S.

h_{final} = 11.55 feet

S_{final} = 1.57 inches

In this final approximation, equations (1), (2) and (3) are satisfied by trial and error with total effective rainfall equal to 9.5 inches.

"Rule of Thumb Guidance for Estimating Downstream Dam Failure Discharge"

BASIC DATA

Name of dam Barden Reservoir Dam Name of town Scituate, R.I.

Drainage area = 33.0 sq. mi., Top of dam 352.20 NGVD

Spillway type = curved, broad-crested; free overflow Crest of spillway 345.10 NGVD

Surface area at crest elevation = 243 acres = 0.38 sq. mi.

Reservoir bottom near dam = 319.0 NGVD (estimated)

Assumed side slopes of embankments 2:1

Depth of reservoir at dam site 33.0 = y_o = 33.0 ft.

Mid-height elevation of dam = 335.5 NGVD

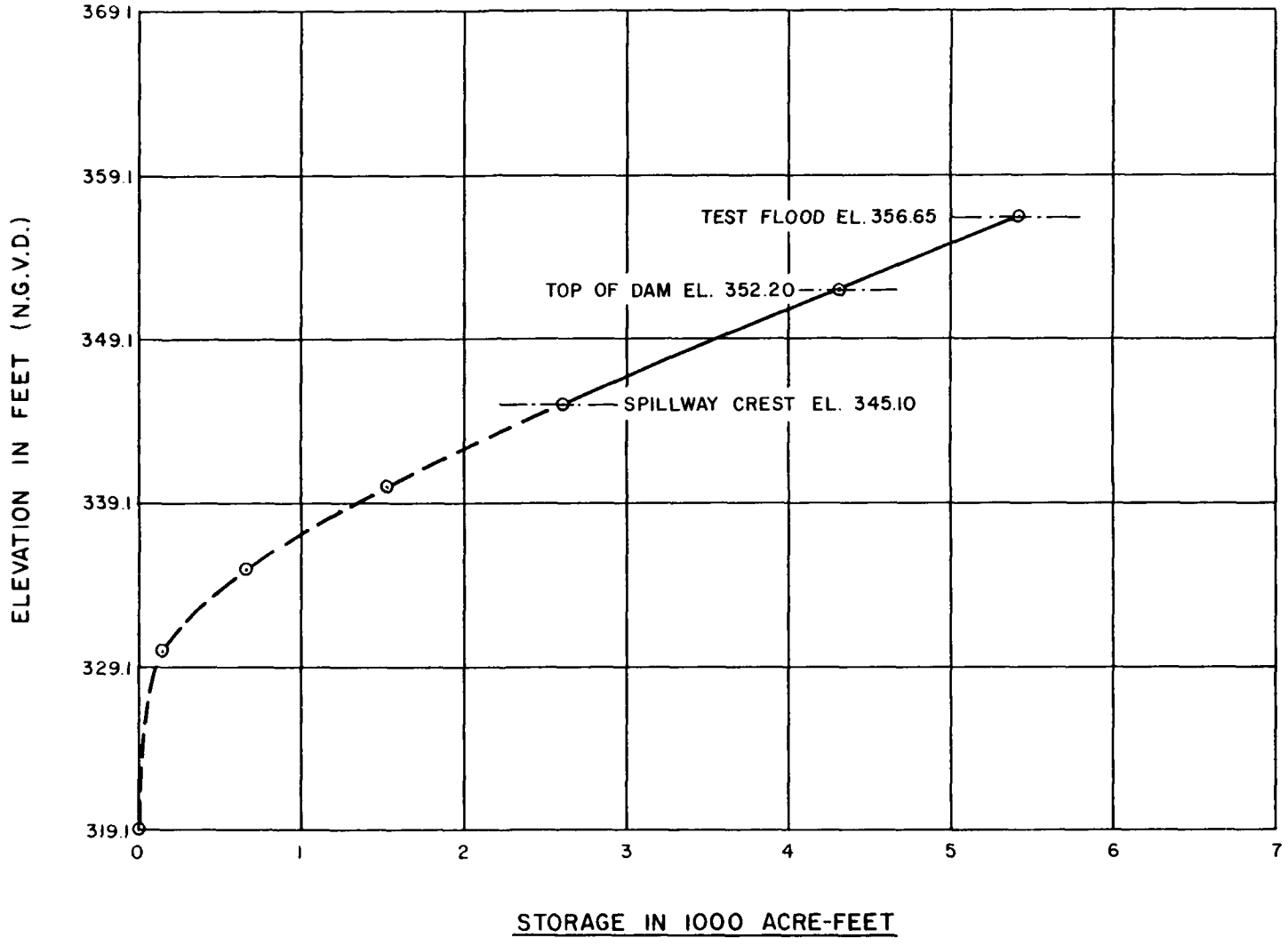
Length of dam at crest = 351.0 ft.

Length of dam at mid-height = 285.0 ft.

20% of dam length at mid-height = W_b = 57 ft.

Width of channel immediately downstream = B = 57 ft.; Shape of Breach = rectangular

Elevation (NGVD)	Estimated Storage in AC-FT	
319.10	0	Bottom of Reservoir
330.10	153	
335.10	675	
340.10	1535	
345.10	2618	Spillway Crest Elevation
352.20	4322	Top of Dam Elevation
356.65	5412	Test Flood Elevation



STORAGE-ELEVATION CURVE

BARDEN RESERVOIR DAM

PLATE D-6

DAM FAILURE ANALYSIS

In addition to energy considerations, the volume of water which is available in the reservoir to sustain the flood wave must be considered. Important energy losses which occur as the flood wave moves downstream include friction losses, bend losses, obstruction losses, expansion and contraction losses, etc. Also the failure discharge and energy losses are reduced by the failure hydrograph being modified with decreasing peak due to available storages downstream. Judgment was used to estimate the most critical situation after the dam failure. Consequently analysis was based upon i) undular wave rather than hydraulic bore; ii) impact of flood wave and the resulting energy loss due to damaged or destroyed structures and sinuosity of the channel were ignored; and iii) the dam failure discharge of 18153 C.F.S. will merge with 4654 C.F.S. already flowing through the existing overflow spillway making a total outflow of 22800 C.F.S. It is assumed that prior to failure, the maximum spillway discharge has already substantially filled the available storage areas downstream. In this case large storage areas are not available and no adjustment of outflow discharge is required. At a distance of 2000 feet downstream the Scituate Reservoir will not allow this large discharge to go through and ponding against this obstruction will convert its wave and kinetic energy back into pressure energy and flow changing to steady and uniform flow with 1.35 depth inside the reservoir.

NOTE: --

1. Adopted water surface elevation is higher of the two values:
   a) ground elevation + $\frac{4}{9} y_o$ - drop in depth

   OR b) ground elevation + d_n
2. There are three depths for different characteristics of flow.
   a) Depth of flow immediately downstream of dam for unsteady flow conditions = $\frac{4}{9} y_o$ = 15.0
   b) Normal depth for $Q = Q_{b_1} + Q_S$ value of discharge = d_n = 15.0 feet
   c) Normal depth for $Q_S = d_n^1$ = 9.0 feet
3. Maximum depth is greater of $\frac{4}{9} y_o$ or d_n = 15.0 feet
   Maximum velocity of flow = $\frac{4}{3}\sqrt{gy_o}$ = 43.3 ft./sec.
   Increase in depth due to failure = (d_n or $\frac{4}{9} y_o$) - d^1 n = 6.0 feet

Barden Reservoir Dam

DAM FAILURE ANALYSIS

NOTES:

1. $W_B \leq B$
2. Failure of dam is assumed to be instantaneous when pool re top of dam, and is a full depth - partial width rectar shaped failure.

STEP 1 - Dam Failure Discharge = Q_b

$$Q_b = \frac{8}{27} W_B \sqrt{g}\ y_o^{3/2} \left(\frac{B}{W_B}\right)^{0.25*} = 1.68\ B^{0.25}\ W_B^{0.75}\ y_o^{1.5}$$

$$= 18153 \text{ C.F.S.}$$

* Reference: Research note No. 5, "Guidelines for Calculating and Routing a Dam - Break Flood by the Hydrologic Engineering Center - C.O.E. - January, 1977.

Maximum Spillway Discharge = Q_S = 4654 C.F.S.

(C = 3.00 B = 82.0 H = 7.10ft.)

STEP 2 - Wave Flow (Unsteady Flow) Characteristics

Depth of flow immediately downstream of Dam = $\frac{4}{9} y_o$ =14.67ft. =15.0feet

Velocity of flow immediately downstream of Dam = $\frac{2}{3} \sqrt{gy_o}$

=21.70 ft./sec.

STEP 3 - Adopted minimum possible depth of flow = 0.138 y_o = 4.55ft.

Actual maximum possible velocity of flow = 2 $\sqrt{gy_o}$ =65.10ft./sec.

Adopted theoretical maximum possible velocity = $\frac{2}{3}$ 2 $\sqrt{gy_o}$ = 43.3

STEP 4 - Normal Flow (typical) Manning's Characteristics

Location of unwashable major obstruction Scituate Reservoir

6000 = ft. D/S

S_o = 0.0058; "n" = 0.065 ; Bed width of channel = b = varies

Total failure discharge = Q = Q_b + Q_S = 22800 C.F.S.

Normal depth of flow for Q (22800 C.F.S.) = 15.0 feet = d_n

Normal depth of flow for Q (4654 C.F.S.) = 9.0 feet = d_n^1

Adopted maximum depth is larger of $\frac{4}{9} y_o$ or d_n = 15.0 feet

Adopted increase in depth due to failure of dam ($\frac{4}{9} y_o$ or d_n) - d_n^1 = 6.0

Adopted maximum velocity of flow = $\frac{4}{3} \sqrt{gy_o}$ = 43.3 ft./sec.

DAM FAILURE ANALYSIS

STEP 5 -

Anticipated adopted minimum wave depth of flow = $d_{minimum}$
$= 0.17\ y_o$ feet = 5.61 feet

Parabolic shaped water surface profile from the dam up to Scituate Reservoir presumably unwashable 6000 ft. (x_{total}) ft. downstream is computed by and adjusted for possible steady and normal flow depth backup in the below given table.

$$(\tfrac{4}{9}\ y_o - d_{min.})\ (\tfrac{x}{x_{total}})^2 = 0.28\ y_o\ (\tfrac{x}{x_{total}})^2 \text{ where } x_{total} = 6000 \text{ ft.}$$

Distance from center line of dam = x	$(\frac{x}{x_{total}})^2$	Drop in depth	Water Surface Elevation as Unsteady Flow	Ground Elevation	Normal Depth	Adopted Water Surface Elevation
0	0	0	352.2 = Top of dam	--		352.2 = Top of dam
0	0	$\frac{5}{9}\ y_o$ = 15.33 ft.	333.87 333.90	319.10	d_n	334.0 = just D/S of dam
500	0.007	0.064	331.94	317.0	15.0	334.0
1000	0.03	0.28	326.72	312.0	15.0	330.0
1500	0.06	0.55	322.45	308.0	15.0	325.8
2000	0.11	1.01	318.99	305.0	15.0	322.3
2500	0.17	1.57	313.40	300.0	15.0	316.8
3000	0.25	2.31	309.70	297.0	15.0	313.0
4000	0.44	4.07	305.93	295.0	15.0	310.0
4500	0.56	5.17	301.80	292.0	15.0	307.0
5000	0.69	6.37	298.63	290.0	15.0	305.0
5500	0.84	7.76	294.24	287.0	15.0	302.0
6000	1.0	9.24	289.76	284.0	15.0	299.0

Note: Adopted water surface elevation is higher of the two values:

a) Ground Elevation + $\frac{4}{9}\ y_o$ = drop in depth

OR b) Ground Elevation + d_n

c) The failure profile was continued for 6000 feet.

Barden Reservoir Dam

COMPUTATIONS FOR
SPILLWAY RATING CURVE AND
OUTLET RATING CURVE COMPUTATIONS

Spillway width = 82.0 feet; Spillway crest elevation = 345.10 NGVD

Length of dam = 351 feet; Top of dam elevation = 352.20 NGVD

C = 3.0

i) SPILLWAY RATING CURVE COMPUTATIONS

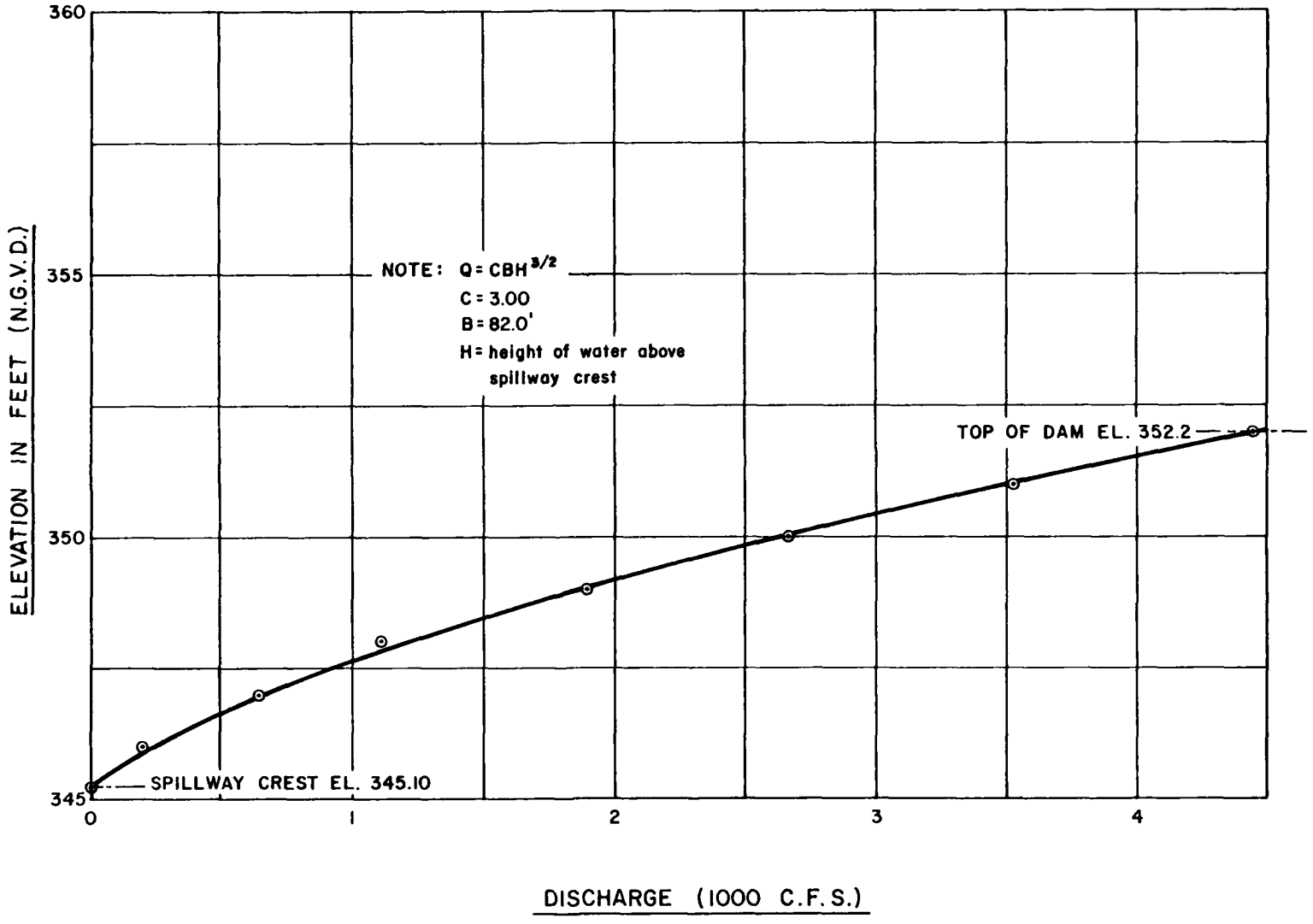
Elevation (ft.) NGVD	Spillway Discharge (CFS)	Remarks
345.0	0	
345.1	0	Spillway Crest Elevation
346.0	210	
347.0	644	
348.0	1215	
349.0	1895	
350.0	2668	
351.0	3525	
352.0	4459	
352.2	4654	Top of Dam Elevation

ii) OUTLET RATING CURVE COMPUTATIONS

Elevation (ft.) NGVD	Discharge (CFS)	Remarks
356.65	151	Test Flood Elevation
355.0	147	
352.2	141	Top of Dam Elevation
350.0	135.7	
345.1	124	Spillway Crest Elevation
340.0	110	
335.0	95	
330.0	77	
325.0	53	
323.0	39.5	
319.95		Center Line of Outlet
318.7	0	Invert of Outlet

Size of outlet = 30"diameter; Area of outlet = 4.90 sq. ft.

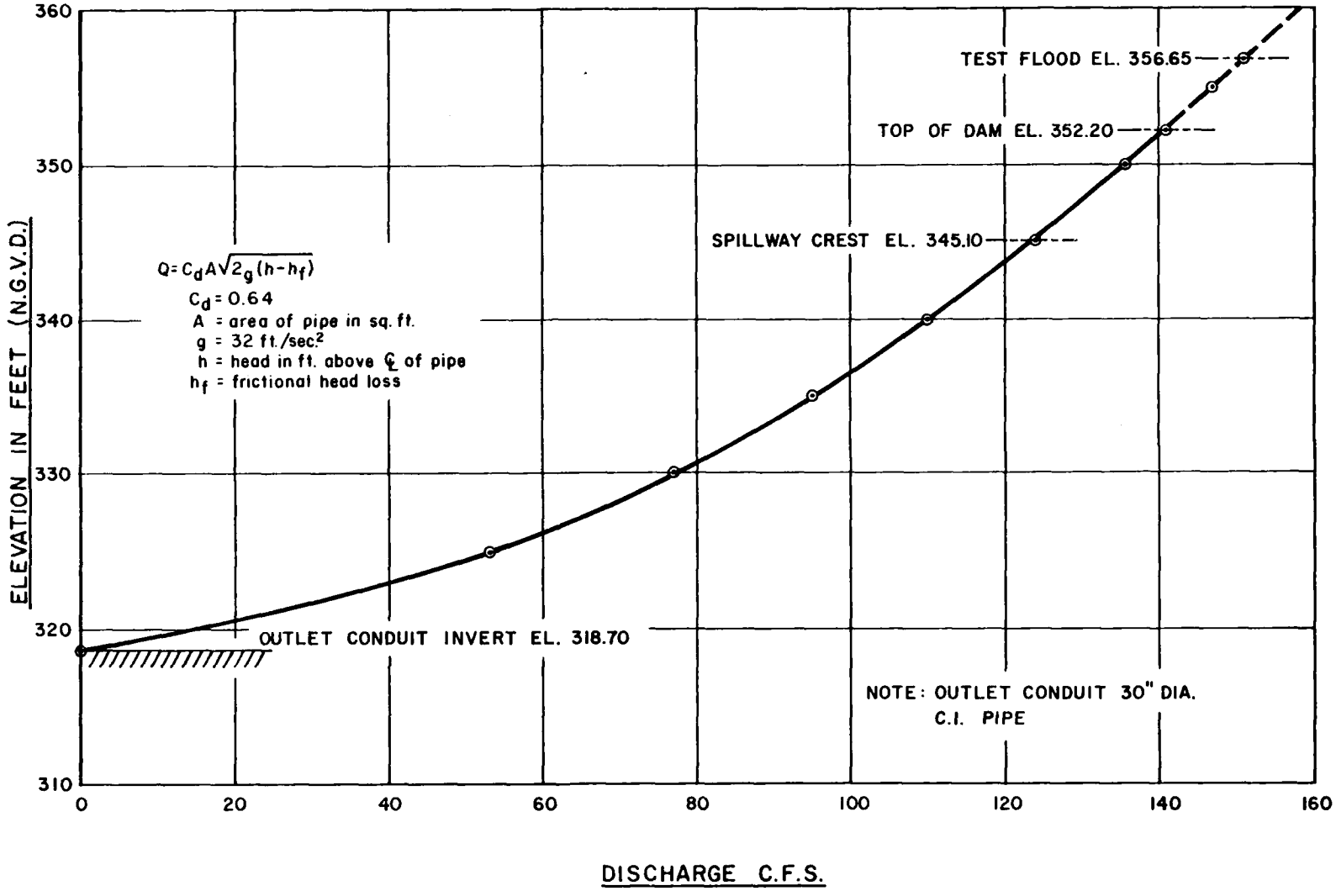
Invert of outlet = 318.70 NGVD; Center line of outlet = 319.95 NGVD



SPILLWAY RATING CURVE

BARDEN RESERVOIR DAM

PLATE D-11



OUTLET WORKS RATING CURVE

BARDEN RESERVOIR DAM

PLATE D-12

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME

END

FILMED

8-85

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